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MANUFACTURING METHODS AND TECHNOLOGY (MM AND T), MEASURE FOR FA--ETC(U)
APR 77 S W KESSLER, R E REED, D R TROUT DAAB07-76-C-8120

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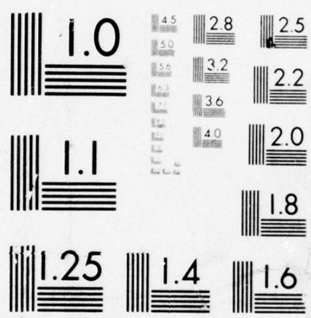

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Second Quarterly Progress Report

MANUFACTURING METHODS AND TECHNOLOGY (MM&T) MEASURE FOR FABRICATION OF SILICON TRANSCALENT THYRISTOR

Period Covered:

1 January 1977 to 31 March 1977
Contract No. DAAB07-76-C-8120

Placed by:

U.S. Army Electronics Command
Production Division
Production Integration Branch
Fort Monmouth, New Jersey 07703

Contractor:

RCA Corporation
SSD-Electro-Optics & Devices
New Holland Avenue
Lancaster, Pennsylvania 17604

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(b) Improved dv/dt Capability

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ACKNOWLEDGEMENT STATEMENT

This project has been accomplished as part of the U.S. Army (Manufacturing and Technology) Program, which has as its objective the timely establishment of manufacturing processes, techniques or equipment to insure the efficient production of current or future defense programs.

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18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Thyristor; High Current SCR; Heat-Pipe Cooling; Power Switching Component; Power Conditioning Component; Solid State Device; Transcalent Thyristor; Production Engineering; Electrical Testing of SCR

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This Second Quarterly Report describes the progress on the MM&TE program for Transcalent (Heat-Pipe cooled) thyristors. A description of the device and the pertinent state-of-the-art on the engineering sample devices is included. Conclusion of redesigning for production is described for the device parts, processes and sub-assemblies. Also described are the check-out and modification of the high current, high voltage test equipment. Actual test results on initial devices are listed.

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20. (Continued)

The present status includes the refinement of the fixtures and the process specifications, the assembly and processing of device parts and sub-assemblies as well as the completed check-out of all but two pieces of the electrical test equipment.

Plans for the next Quarter include completion of the engineering sample devices; electrical, mechanical and environmental testing of these samples as well as initiate planning of the Confirmatory sample phase.

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MANUFACTURING METHODS AND TECHNOLOGY (MM&T) MEASURE FOR FABRICATION OF SILICON TRANSCALENT THYRISTOR

Second Quarterly Progress Report

Period Covered: 1 January 1977 to 31 March 1977

Object of Study: The objective of this manufacturing and methods technology measure is to establish the technology and capability to fabricate Silicon Transcalent Thyristors.

Contract No. DAAB07-76-C-8120

Approved for public release; distribution unlimited

Prepared by:
S. W. Kessler
R. E. Reed
D. R. Trout

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ABSTRACT

This second quarterly technical report on the MM&TE Contract DAAK07-76-C-8120 for Transcalent (Heat-Pipe cooled) Thyristors describes the device and the pertinent state-of-the-art in the midst of the engineering sample phase of the program. Progess on redesigning the parts, sub-assemblies and processes for production is described. Also, the problems encountered in transferring the diffusion of the high current, high voltage silicon wafers from one plant location to another are described.

Also included are details of the assembly sequence, the electrical/environmental tests to be performed and the latest status of the test equipment that has been built for this program.

Present status includes the refinement of the fixtures and the process specifications, the procurement of all of the parts for the thyristor units and the completion of initial device fabrication, as well as the completion of all but two of the various test circuits. Actual test results on the first three devices reveal conformance with most of the electrical, mechanical and thermal specifications.

Plans for the next quarter include completion of the wafer diffusion transfer, fabrication and evaluation of additional engineering sample thyristors, and environmental testing. Delivery is now scheduled during the next report period.

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TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF ILLUSTRATIONS AND TABLES

LIST OF ILLUSTRATIONS AND TABLES (Continued)

Appendices

PURPOSE

The purpose of this production engineering contract is to establish the technology and capability to fabricate heat-pipe cooled semiconductor power devices, silicon Transcalent Thyristors, Type J-15371. The subsequent pilot production of these devices is a part of the contract. This report covers the efforts performed by the contractor in the second three months to modify the device for production, establish process and fabrication methods as well as to modify and construct the various types of test equipment required to adequately characterize the thyristor. Plans for future work are also presented, corrective action is delineated for problems that have been encountered and other information is discussed to help assure that the purpose of the contract is accomplished.

This contractual MM&TE program will establish the production techniques, establish quality control procedures and verify a pilot production capability for the J-15371 thyristor, conforming to the drawing attached to AMENDMENT 1 of SCS-477. Electrical, mechanical, and environmental inspections are a part of the program as well as extensive documentation requirements, per DD1423. No high volume production facilities exist at the present time for this military type of solid-state power device, but production planning constitutes Step II of the contract. Thus, the time required to produce future large quantities of the J-15371 will be reduced for either current military requirements or future emergency requirements. Reduction of the reproductive costs are an important objective.

The J-15371 thyristor is a 400 amperes RMS, forced air cooled solid-state power control device, utilizing integral heat-pipes for improved cooling efficiency, lighter weight and smaller size than the conventional devices with their external heat-sinks attached. Improved reliability results from these innovations. A blocking voltage capability of 800 volts minimum at 125° Celsius is a requirement. Original R&D efforts were conducted successfully by RCA under Contract No. DAAK02-69-C-0609, for MERADCOM, Ft. Belvoir, VA. Potential applications include power conditioning, power switching, phase control and motor speed control equipments.

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GLOSSARY

All abbreviations, symbols and terms used in this report are consistent with the Electronics Command Technical Requirements SCS-477, dated 5 December 1974. This Technical Requirements document, in turn, references MIL-S-19500 for the abbreviations and symbols used therein except, as follows:

V_{GR} = Reverse Gate Voltage

I_{GR} = Reverse Gate Current

Note: The format used for this report is that specified in the DD 1423, namely, ECIPPR No. 15, Appendix C, augmented by MIL-STD-847A. Sub-section numbering is based on Appendix C and the applicable test methods are those referenced in MIL-STD-750B.

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NARRATIVE AND DATA

1. Device

a. Description of the Structure - Refer to pages 9-13 of the First Quarterly Report for a description of the Transcalent Thyristor device, the applicable reports, patent coverage as well as the advantages of this heat-pipe cooled technical approach.

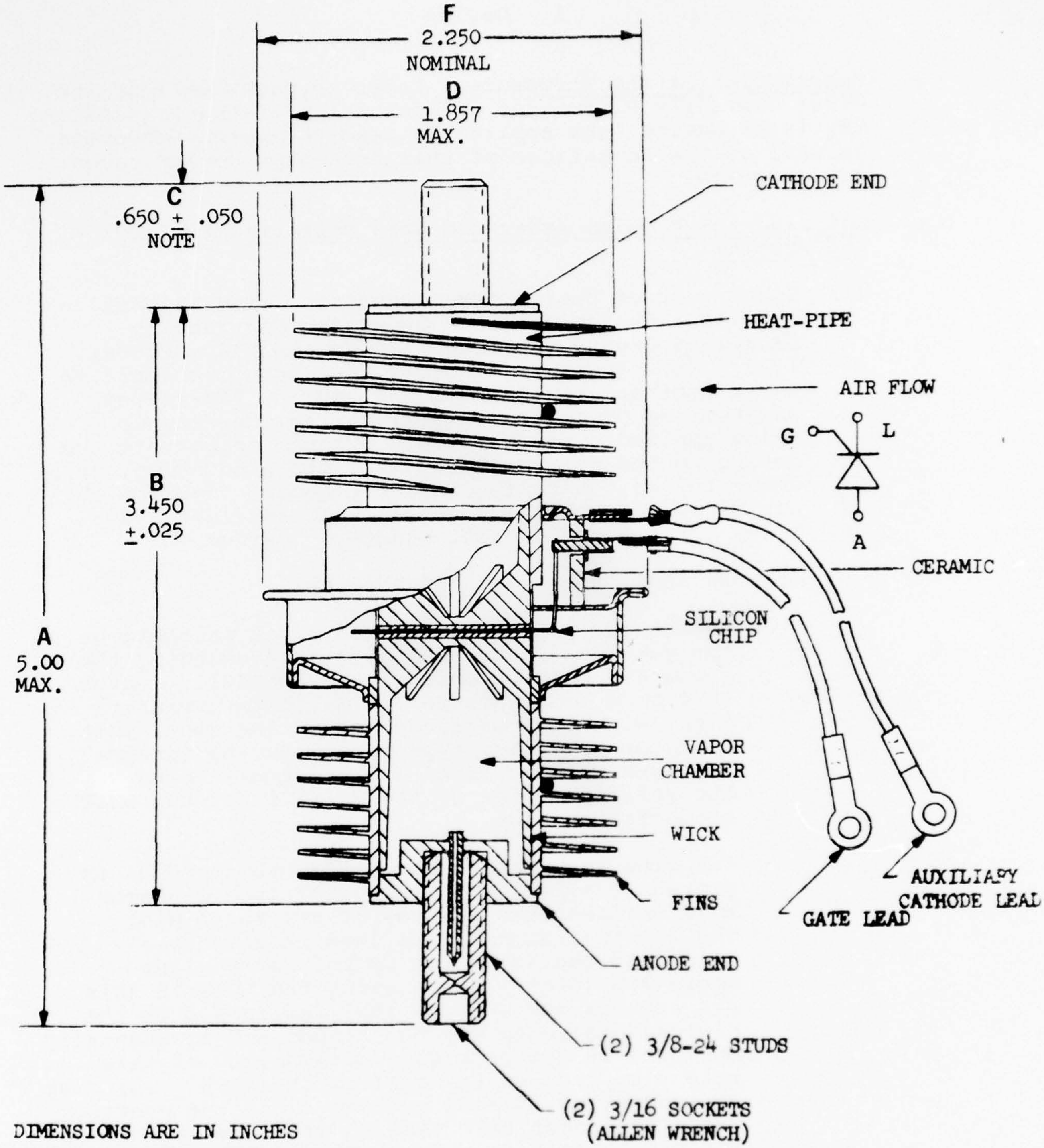
b,c. Defining the Problem Areas and Work Performed to Resolve the Problem

(1) Conversion of Design for Production - The Transcalent thyristor design achieved under R&D Contract No. DAAK02-69-C-0609 was described in the FTR, October, 1972. Subsequent refinements have been incorporated under contract N62269-73-C-0635 and by RCA-funded engineering projects. Additional engineering is being applied under the MM&TE program to convert the design to one even more suitable for production, as described in the First Quarterly Report covering the period 27 September 1976 to 31 December 1976 and below for the most recent quarterly period

(a) Refined Gate Lead Feed-Through

Recent design refinements involved relocating the gate lead, necessitating interchanging the anode and cathode ends of the J-15371. (Refer to Figure 1 of this report.) These variants; along with the continued use of the two-inches diameter Wolverine type tubing having integral, extruded cooling fins; are incorporated into the refined design of the J-15371 for the MM&TE production design.

The gate lead feed-through has been farther improved by eliminating the 0.047 inch diameter hole drilled into one end of the Kovar pin. The internal nickel gate lead is then spot welded to the Kovar pin by forming a right angle lap joint. Eliminating the hole in this pin reduces the chances that residues from the cleaning reagents may be trapped and accidentally enclosed in the package. Elimination of this hole also reduces the cost of the part. The cost of assembling is also reduced since the operator needs no longer take time to wrap the wire around the pin to hold it temporarily in place during the braze operation.



DIMENSIONS ARE IN INCHES

● TEMPERATURE MEASUREMENT POINT

NOTE - THREADS - 0.550" MIN.

GATE LEAD LENGTH = 6" MIN. E

Figure 1. Transcalent Thyristor Type J-15371 Cross-Section Drawing

(b) Improved dv/dt Capability

Another change described in the last Quarterly Report was to increase the number of shorting dots employed in the cathode pattern. The reason for this pattern change was that an induced current flows in the gate layer when there is a rapid rate of change of blocking voltage (dv/dt). The p-base gate layer has a relatively high resistance because it is lightly doped, thus when the voltage gradient reaches the range of 0.25 to 0.6 volt, especially at high junction temperatures, the thyristor may be unintentionally gated into conduction. The smaller the gate layer resistance, the greater is the rate of change which the thyristor can experience without being unintentionally gated into conduction.

In the R&D contract there was only one 0.030 inch diameter shorting dot in the center of the cathode contact area. This dot was 0.385 inch from the periphery of the gate to emitter junction. The dv/dt capabilities of these older devices were thus somewhat limited. An external Gate-to-Cathode resistor was attached frequently at test to improve this characteristic. This gate layer resistance can be decreased internally by evenly distributing a large number of shorting dots during the diffusion of the cathode area.

A set of photo-masks of this improved configuration was procured and used for the initial engineering sample wafers. The first group of such wafers processed were used in the devices tested in the second quarter. The results are reported in section 5 of this report. A further improvement appears to be desirable for use on the Confirmatory samples to be produced later in this contract. Using the highest practical dv/dt capability will increase the yields of the subsequent devices.

In an interim change, the mask for diffusing the emitter contact area was increased by 0.010 inch in diameter to completely enclose all of the shorting dots. The first wafers processed employed a mask in which the metallic contact to the emitter bisected the outermost ring of shorting dots. Subsequent lots of silicon wafers will use the interim masks.

After consultation with RCA Solid State Power Device engineers at Somerville, NJ, the shorting dot pattern will be changed a third time to increase the diameter of the dots from the present 0.004 inch to 0.010 inch. The same spacings and loci will be used. The reason for this latest change is that the lateral diffusion of the adjacent phosphorus dopant effectively decreased the dot diameter to 0.002 inch or less. It is suspected also that many of the shorting dots were electrically insulated on some wafers by more rapid surface diffusion of the silicon. The larger dot size will allow for some of this lateral diffusion to occur without blocking out sections of the pattern.

The open or insulated shorting dots were detected through curve tracer probing the wafers. A degraded diode characteristic was sometimes noted between contacts made to a dot and to the gate ring. Normally there should be a resistive rather than a pN junction characteristic between these two contacts. Also the gate currents of some of the wafers were less than the design value. Open or reduced area shorting dots would account for these discrepancies.

Dv/dt tests of some of the initial devices verified this conclusion that larger dots were needed. Improvement of the dv/dt value occurred at test when an external resistor was attached from gate to cathode, thus indicating the internal shorting dot pattern was not fully effective.

However, for future wafers, the cathode area on the masks must not be reduced excessively by the larger shorting dots. Calculations show that 95 percent of the cathode area will be retained and this is adequate for the maximum rated on-state current of the J-15371.

(c) Diffused Silicon Wafers

Difficulties have been encountered in transferring the diffusion technology from the Somerville to the Lancaster locations. Devices built with the initial Lancaster diffused wafers have exhibited satisfactory leakage currents at room temperature but excessive leakage currents at high temperatures. Some lots were difficult or impossible to turn-on with practical gate current values.

The former difficulty is especially troublesome because even though the devices meet most of the electrical characteristics at test, one of the minimum acceptance requirements specified in Section F.47 of the contract is the high temperature, forward blocking current of Table I, Group A, Subgroup 3. Engineering sample devices that meet all other acceptance criteria thus cannot be shipped. The contracting officer has been notified of this shipping delay.

This problem has been solved on subsequent lots of wafers by refining the slow cooling processes, by adding a soak at temperature during densification of the polysilicon, and by reducing the strains induced by excessive sticking of the wafers in the deposition furnace boat.

These three changes from the first group of wafers to be processed reduced the leakage currents at 800 volts and 125°C to about 15 milliamperes. This is an improvement by a factor of 3 to 4 from the first wafers to be processed in Lancaster. Unfortunately, blocking voltages have deteriorated on some lots having the desired low leakage currents. This latest problem of blocking voltages has been traced to an apparent phosphorus cross-contamination of the boron deposition and diffusion furnaces. This problem is well along to being solved. It is typical of the problems encountered in transferring a complicated process with numerous critical processing steps from one engineering activity to another with different personnel and different facilities. It has been found necessary to introduce new control points to confirm the quality of the wafers at each step in the diffusion procedure.

The difficulties of not being able to turn-on the gates from the chips of two groups of wafers was traced to etching the moat too deeply around the periphery of the emitter. This etch is now specified as one-half to two-thirds of the emitter diffusion depth as determined by Zeiss microscopic measurements recorded before proceeding with the etch. Measurements are also made at increments of time during the etch to control the depth accurately. Wafers processed in this manner have the correct gate current values.

One lot of wafers having all of these problems corrected has just been lost because of a one-half hour power failure that occurred during the Chemical Vapor Deposition metallizing operation. Attempts at salvage have been unsuccessful.

To avoid any further delays in the delivery of the engineering sample devices, it has been decided to metallize and assemble devices using the few remaining Somerville-diffused wafers. These are being followed-up by additional lots of Lancaster-diffused wafers that utilize all of the process improvements determined above.

d. Conclusions

The device component refinements described above, along with the design refinements incorporated or planned, are expected to produce a J-15371 device to meet the specifications and inspections of SCS-477. Although more wafer diffusion transition difficulties have been encountered than anticipated, RCA management and technical personnel are confident that this accelerated effort being applied will assure that future Lancaster-diffused wafers will conform to the MM&TE specifications. Much of the time delay incurred on the engineering samples is expected to be recovered in the confirmatory sample phase of the contract.

e. Drawings

Drawings of the piece parts and sub-assemblies of the device were included in the First Quarterly Report. The drawing of the complete device is shown in Figure 1 and any major revisions of the parts drawings are included in Appendix A of this Second Quarterly Report.

2. Process, Equipment and Tooling

a. Purpose of Each Step

(1) Device Processing and Tooling

Figure 4, Engineering Drawing No. 3025577 in the First Quarterly Report showed the flow of parts through the various assembly steps and a descriptive title was listed for each operation. Also shown were the subassembly drawings and the fixture drawing numbers for each operation.

Flow process cards are also being used to record and control the flow of parts through the laboratory. Examples of these cards were shown in Figures 5 and 6 of the First Quarterly Report. The form TL 4825 cards in Figure 5 are being used to record the metallizing and electrical test data of each lot of wafers (chips). The cards in Figure 6, Form TL 4827, are being used to record the data in fabricating the heat-pipes, ceramics and their assemblies into the finished devices ready for exhaust processing.

(2) Electrical and Environmental Test Equipment

The flow chart of the electrical and environmental testing sequence was given in Figure 7, Drawing No. 3025578, of the First Report. The name of the test was given as well as the special conditions and the MIL-STD-750B method number. Also, listed were the sampling percentages for the pilot run. Long time tests had the time interval indicated in the figure. This chart remains valid for the program.

Test Data Record Forms with actual results recorded are included in Table 3a, b, c and d. These forms will be used to record the actual test results on all of the future units after exhaust processing is completed.

b,c. Problem Areas and Work to Resolve Problems

(1) Device Processing and Tooling

Fabrication processes that are known to limit RCA's production capabilities for Transcalent thyristors are being improved by increasing the number of units per operation and by reducing the labor content with fixtures and simplified operations.

(a) Contouring and Etching of the Chip

The diffused and metallized wafers have previously been cut to size (one chip per wafer) with a precision sand blaster and contoured while cemented on a mandrel, Dwg. No. 3025564.# After contouring, the chip was usually removed from the mandrel and solder dipped, the metal surfaces were painted with wax, the contoured edges were etched and the wafer was tested for both forward and reverse blocking voltages and leakage currents.

This contouring and etching of the silicon chip was a labor intense operation because two operations must be done under a microscope employing the skills of the unaided operator's hand.

To reduce the amount of labor involved in this operation, it has been proposed that the etching and testing be done while the chip is still on the mandrel. To protect the metallizing, a protective coating would be spun onto the wafer in the same way as photoresist is applied and then the contour cut would be made through the coating onto the silicon. To protect the mandrels from the acids, it was proposed that they be made of a notably corrosion resistant alloy. The various alloys evaluated were listed in the last report.

Tests have now been conducted contouring the wafers on a type 310 stainless steel mandrel with a thin film of parafin wax on the metallized collector surface. Gycol wax was used to bind the wafer to the mandrel. During the FAN etch process, it was discovered that the gycol wax softened and migrated onto the contoured edge, retarding the etching. Gycol wax

#Tool, fixture and mask drawings were included in Appendix B of the First Quarterly Report.

was used for binding because its strength and hardness permit a sharp edge to be maintained on the silicon chip during coating. Parafin wax is too soft and melts from the heat generated during the contouring operation.

Therefore, a new approach to masking was tried by forming Viton rubber pads on PVC paddles. A photograph of the assembled mask is shown in Figure 2. The etching is done by clamping the wafer between the paddles and then submerging it in the acids. Successful etching has been performed using this masking fixture but it is too difficult to load and unload the fixture making it cumbersome for production. Additional refinements will be considered.

(b) Soldering of Chip to Heat-Pipes

The method of solder dipping the chip and soldering it to the heat-pipes was discussed previously. This R&D process required a great deal of skill in that the alignment of the three parts was made by eye. To de-skill this assembly operation, it was proposed that a two-part demountable fixture be designed for fixturing the parts and that solder preforms be tried instead of solder dipping. The fixture was of a split design so that it can be easily removed from the assembly. The fixture has three concentric surfaces for positioning the three parts. The two smallest concentric surfaces fixture the heat-pipes. The center cylindrical surface was made slightly larger than the largest chip. With these dimensions, the small space between the fixture and the edge of the wafer can be used to gauge the alignment of the chip and the surface of the fixture does not come in contact with the fragile contoured edge of the chip.

In Figure 3 is a photograph of the soldering fixture. A cross-section of the fixture with a device positioned in it is shown in Drawing #3025289. The base of the fixture generates a cylindrical reference surface for a split ring which positions the silicon chip and the cathode heat-pipe. A weight is applied to the cathode heat-pipe. A lead-tin solder alloy is used to join the silicon to the heat-pipes. The soldering is done in an RCA proprietary furnace atmosphere which ensures uniform wetting by the solder and virtual freedom from voids at the faying surfaces.

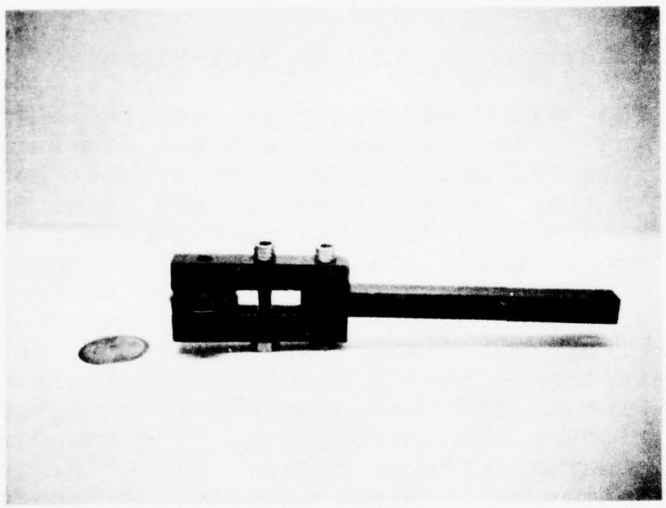


Figure 2. Experimental Viton Rubber Pad Etching Fixture: The contoured silicon chip (shown on table top) is clamped between the discs. A rubber seal around the edge of each disc protects the metallizing on the silicon wafer from the etching acids.

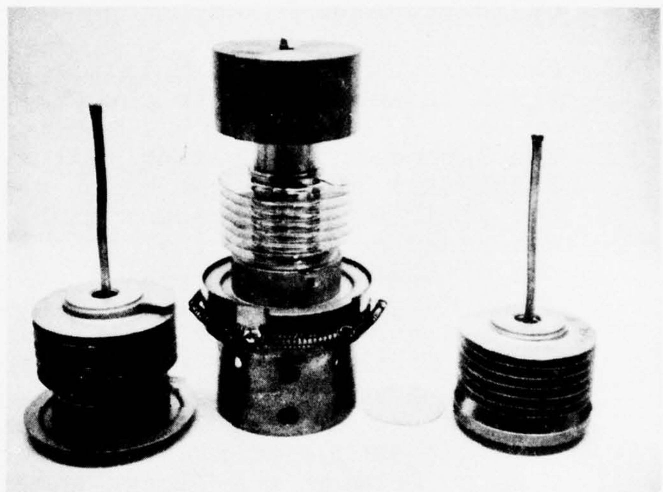


Figure 3. Soldering Fixture: The fixture shown positions the cathode heat-pipe with respect to the anode heat-pipe. The flanges on both heat-pipes are used as a reference. The inside diameter of the split ring which locates the two heat-pipes is machined slightly larger than the diameter of the silicon wafer. The spring wrapped around the split ring holds the fixture in place during soldering.

The soldering fixture (Drawing No. 3025289) has been built and used to make successful assemblies. A photograph of a device ready to be soldered is also shown in Figure 3. The fixture has also been used to make successful assemblies using both the new solder preforms and the older style solder dipped chips. After soldering the contoured edge of the silicon chip is coated with a silicone passivation coating and this coating is cured using the manufacturer's recommended schedule.

(c) Brazing Fixtures

Brazing fixtures were designed to fabricate lots of 16 sub-assemblies.

Photographs of these multiple position brazing fixtures were shown in the First Quarterly Report.

The cathode body brazing fixture (Drawing No. 3025290R1) has had two major changes to improve the yield of good, vacuum tight assemblies. It was found necessary that a weight be applied to the cathode flange, Drawing No. 3025225R2, and a new weight was designed, Drawing No. 3025585, to hold the heat-pipe in the fixture. The weight on top of the flange is split so that it can be removed after brazing. This extra weight for the fixture was necessary because the flange was not flat enough to prevent vacuum leaks from occurring between the flange and the ceramic insulator.

The weight on top of the heat-pipe was changed because it was found that the wicking mandrels could not be left in the heat-pipes as weights. A photograph of the parts of this modified fixture are shown in Figure 4.

The flange is brazed to the anode heat-pipe using fixture Drawing No. 3025232. This fixture maintains the correct distance from the end of the heat-pipe to the flange when the braze solidifies. The exhaust tube for the center chamber is brazed into the flange at the same time the flange is brazed to the heat-pipe. The braze material used is the silver-copper eutectic. The weights of Drawing No. 3025231 or No. 302590R1 are used to hold the heat-pipe in the fixture.

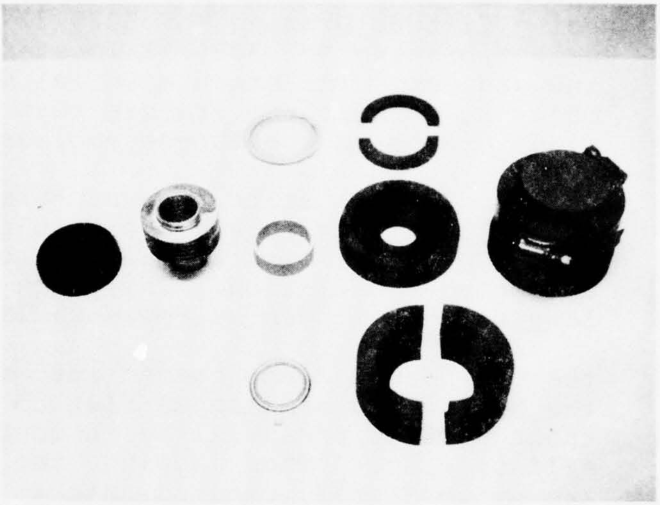


Figure 4. Revised Cathode Heat-Pipe Brazing Fixture: The cathode heat-pipe brazing fixture was modified to add a weight to the flange soldered on top of the ceramic. Since the flange diameter is less than the fin diameter of the heat-pipe, the weight is split into two halves so that it can be removed after brazing. A new weight was also designed for weighting the heat-pipe into the fixture.

No difficulties have been encountered in making these vacuum joints. A photograph of four of the sub-assemblies in the fixture is shown in Figure 5.

The heat-pipe exhaust tube is brazed into the heat-pipe with the silver-copper eutectic brazing material using fixture Drawing No. 3025558. This tube is self-fixturing in the hole at bottom of the end cap, Drawing No. 3025212. A photograph of a number of these sub-assemblies is shown in Figure 6.

The end cap sub-assemblies are brazed into both the anode and cathode heat-pipe sub-assemblies using fixture Drawing No. 3025232 with the weight, Drawing No. 3025231, located on top of the end cap. The braze material is Incusil which melts at a lower temperature than all of the previous brazes in the sub-assemblies. See Figure 7.

After the final braze, the sub-assemblies are helium leak checked and the heat-pipes backfilled with nitrogen to maintain cleanliness and prevent oxidation. The pinch-off is made long so that it can be reopened later.

The molybdenum discs brazed into the ends of the heat-pipes are lapped flat so that all of their surface area will be in contact with the silicon chip. After lapping, the sub-assemblies are hydroblasted, cleaned, nickel plated and the plating fired at 550°C to ensure its adherence. This plating must be free of blisters during soldering. Blisters would increase the thermal impedance of the device and increase the on-state voltage drop.

(d) Heli-Arc Welding

New heat sink fixtures were designed and built for more rapid clamping onto the devices for heil-arc welding the Kovar and steel parts. This fixture is shown in Drawing No. 3025566 along with a device mounted in the welding fixture. A photograph of the set-up is shown in Figure 8.

A Heli-arc torch with a non-consumable electrode is used to fuse the weld ring to the device. The torch provides an inert Argon atmosphere around the area of the weld.

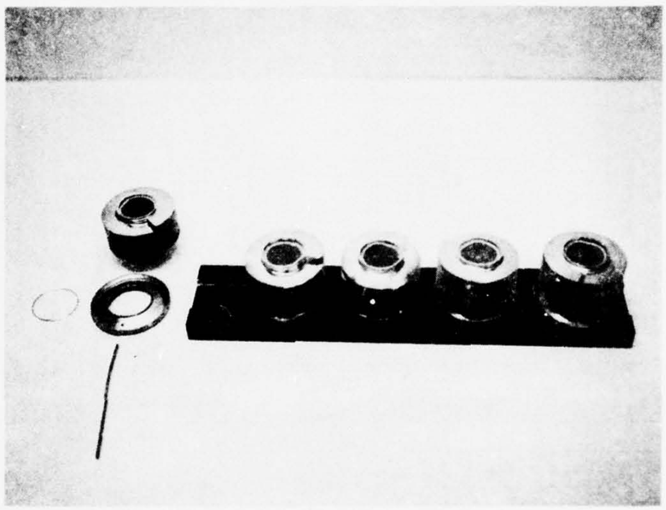


Figure 5. Anode Heat-Pipe to Weld Flange Brazing Fixture: Four subassemblies are shown in the brazing fixture. The distance between the flange and the end of the heat pipe is fixed. The parts which are brazed together, namely, the heat-pipe, flange, braze ring and exhaust tubulation are shown to the left of the fixture.

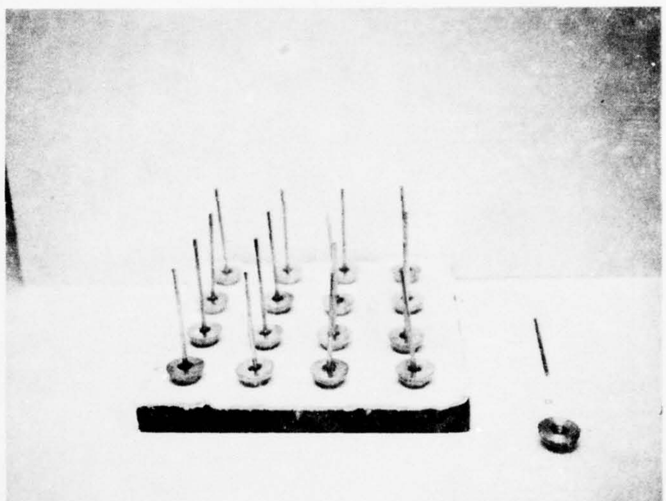


Figure 6. Exhaust Tube Brazing Fixture: The copper exhaust tubes are self-fixturing in the holes of the end caps as shown. The Fiberfrax sheet permits a short length of the exhaust tube to extend through the end cap for added support.

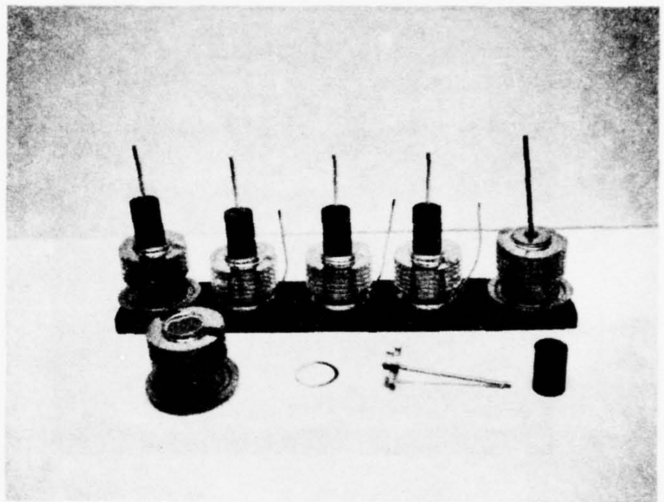


Figure 7. End Cap Brazing Fixture: End caps are brazed into the heat-pipes as shown. The weight is necessary to insure proper seating of the end cap.

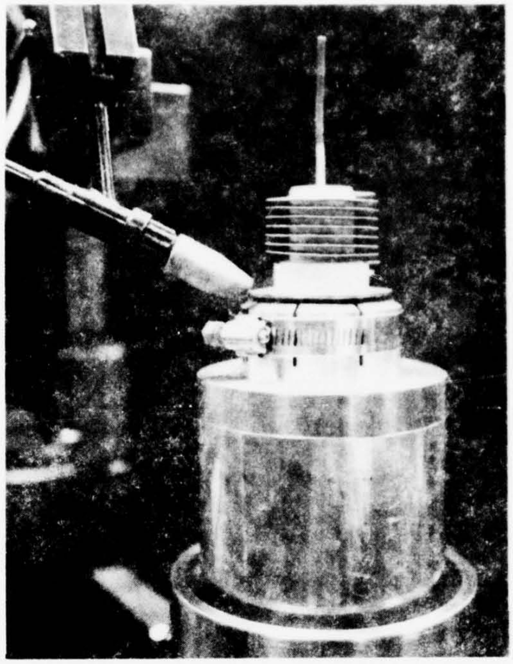


Figure 8. Heliarc Welding Fixture: A device clamped into its welding fixture heat sink is shown. During welding, an arc extends from the torch on the left to the flange. The second weld is made by turning the device over and inserting it into the bottom of the heat sink fixture.

To make the flange weld, the device is turned over in the welding fixture. It is important that the heat-pipes be electrically shorted to one another during welding to prevent degradation of the silicon junctions by the high voltages used in starting the arc.

The welds obtained with the heliarc welding are strong, equal to the thickness of the material being joined. A strong weld is desirable to transmit any external stresses applied to one heat-pipe to the other heat-pipe through the weld ring rather than through the more fragile silicon chip.

(e) Exhaust Processing

The center chamber of the Transcalent package is exhausted on the vacuum system shown in Figure 9. Presently two devices can be exhausted simultaneously on the manifold. Work to increase the capacity of the exhaust system will be deferred until the confirmatory sample phase of the contract. The two position exhaust is adequate for the engineering samples. The manifold on the vacuum exhaust position will be modified so that more devices can be exhausted simultaneously.

During exhaust an oven is placed over the devices to bake them for a more thorough degassing. After several hours of vacuum pumping, the system pressure is comparable with that of a high vacuum power tube. When the devices are cooled they are valved off from the vacuum system and the center chamber that contains the silicon chip and the ceramic insulator is back-filled with dry nitrogen.

The exhaust system may also be used to calibrate for thermal impedance testing during exhaust processing. In this way, it will be possible to calibrate the forward voltage of each device versus the temperature while on exhaust bake-out and thus, eliminate an extra operation. Calibration is done by conducting direct current through the thyristor in the forward direction and measuring the forward voltage drop across the device at selected temperatures, the plot of this temperature versus the measured forward voltage drop can

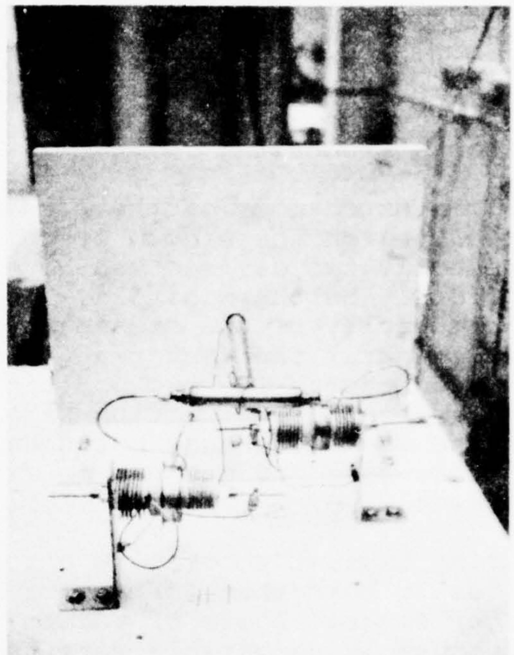


Figure 9. Exhaust System: The center chamber housing the contoured edge of the silicon wafer is exhausted and baked on the system shown. Each device is attached to the manifold extending through the insulating board in the background. The oven, not shown, is placed over the devices during the exhaust for bake-out. After baking the units the manifold is valved-off from the vacuum system and the devices are back-filled with dry nitrogen.

be used to interpret the junction temperature during later thermal impedance testing. The forward voltage drop is a temperature-dependent parameter.

The exhaust/back-filling system for the heat-pipe is shown in Figure 10 and in Drawing No. 3025571. In the engineering configuration there is provision for only one device on the manifold. At a later date the manifold can be expanded to three or more devices to save vacuum pumping and back-filling time. This manifold fits on top of the helium leak detector so that all of the heat-pipes can be leak checked before processing.

A three-way valve is used to process the heat-pipe. The valve is first used to pump out and then to close-off the heat-pipe from the vacuum system. In the third position of the valve, a measured volume of ultra-pure water is allowed to flow from the pipettes into the heat-pipes. The quantity of water is equal to the pore volume of the heat-pipe wick. The device can then be pinched-off from the system.

The exhaust tubing on the heat-pipes is usually pinched-off longer than needed so that the device can be placed back on the system if it becomes necessary to salvage or reprocess the heat-pipes. After satisfactory testing, the tubing is short-pinched to facilitate its hidden position inside the stud on the finished device.

The following operations are the finishing operations after the heat-pipes are back-filled with the measured quantity of water:

Nickel plate the entire device,
Apply the label identifying the type no., serial no. and manufacturer,
Coat the weld ring and ceramic with a protective conformal coating,
Insert the threaded studs into the end caps, and
Attach the gate and auxiliary emitter leads.

The device is now ready for the mechanical, electrical and environmental inspections in accordance with SCS-477.

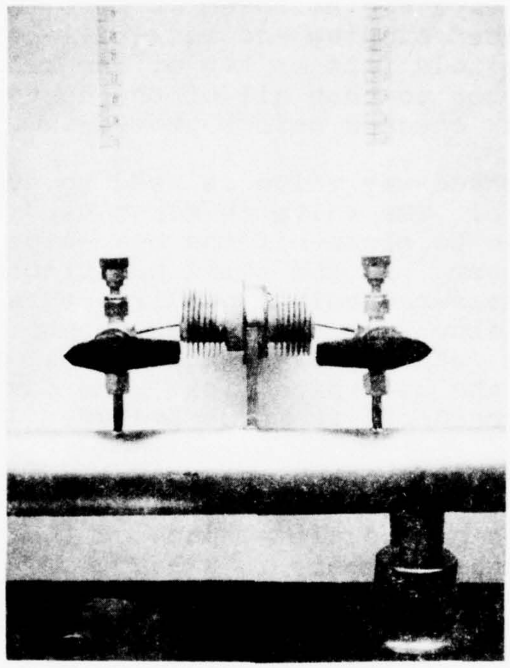


Figure 10: Heat-Pipe Back-Filling System: The Transcalent Thyristor is mounted on the manifold on top of the leak detector between the two three-way valves. The heat-pipes are first exhausted and leak checked. After helium leak checking, the valves are turned to admit enough ultra-pure water from the pipettes to fill the pores in the wick of the heat-pipes. The heat-pipes then are valved off from the system. The device is removed from the system by pinching through the copper exhaust tubing on each end.

(2) Electrical Test Equipment

(a) Status

All but two of the test equipments have now been assembled, modified and checked out as required for the total of 41 different tests (13 methods) for SCS-477, Tables I, II & III, dated 5 December 1974 as amended 31 August 1976 by Amendment 1. Only the surge current and turn-off time test sets remain to be completed. Design considerations and actual calculations for these two sophisticated test sets were included in the First Quarterly Report. The check-out of both equipments will be completed in the next report period.

All of the test equipments are listed in Table 1 along with the required modifications and present status. The tests to be performed in each equipment are listed in Table 2. Actual test results are listed in Section 5, "Data and Analysis." Test procedures are included in Appendix C.

The first, second and eighth test equipments are portable, as noted previously, and were moved to the environmental laboratory for the tests listed under Sub-Group 2 of Table II, Group B and for the test listed under Sub-Group 3 of Table III, Group C inspections in SCS-477. All equipment operated satisfactorily in the remote locations.

Functional block diagrams for each of the test sets were included in Appendix C of the First Quarterly Report.

(b) Exponential Rate of Voltage Rise Test Set

Operation of the exponential rate of voltage rise (dv/dt) test set produced disastrous results when modified to the specified value of C (one microfarad) as well as with the voltages V_{AA} and V_{FB} equal to 800 volts. The synchronous switching SCR, S1 in Figure 11, failed catastrophically when the peak surge current exceeded the ratings as R1 was reduced to zero ohms to achieve the required minimum dv/dt rate of 200 volts per microsecond. R6 had not yet been installed to limit the maximum surge current in the supply to 200 amperes. Note that C1 in Figure 11 is the same component as C in SCS-477, Method 4231.

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TABLE I

ELECTRICAL TEST EQUIPMENT SURVEY

	Description	Ratings	Equipment Modifications Required	Status of Equipment	Remarks	Block# Diagram
1.	Blocking Current Test Set	800 V. peak 120 mA peak a.c. Forward and Reverse Polarity. 60 Hz	Engineer design, order components, construct, and check out portable supply for a.c. method, as required. Interconnect with oven and vacuum chamber, as required, with safety interlocks.	Vacuum Chamber available. V_{FBOM}/V_{RBOM} Supply completed and checked out in Dec., 1976. Temperature controlled oven available, controller repaired and checked out for maintaining 125 $^{+0}_{-3}$ °C Equipment operated satisfactorily for all applicable tests.	D.C. method facilities available, but a.c. method specified for acceptance tests under this contract.	Page C5
2.	Gate Trigger Voltage and Current Test Set	6 & 10 V.D.C 1 ADC Forward & Reverse Polarity	Engineer design, order components and construct portable supply for use in the environmental lab as well as in the Transcalent Lab.	$V_{GT}/I_{GT}/I_{GR}$ supply completed and checked out in Dec., 1976. Equipment operated satisfactorily for all applicable tests. Oven of Test Set 1, above, also to be used.	Only a Tektronix 575 Curve Tracer was available for these tests previously. Range was limited.	Page C6

TABLE I (Continued)

ELECTRICAL TEST EQUIPMENT SURVEY (Continued)

	Description	Ratings	Equipment Modifications Required	Status of Equipment	Remarks	Block # Diagram
3.	Blocking Voltage Life Test Set	800 V. peak 2.7 A. peak a.c. Full Wave Polarity 60 Hz 6 positions	Engineer design, order components, construct and check-out supply in accordance with Fig. 2 of SCS-477, modified for an Rl of 300 ohms, as previously approved.	V_{FBOM}/V_{RBOM} supply, fuses and timer completed and checked out in Dec., 1976. Temp. controlled oven of Test Set 1, above, to be used for this test, too. Equipment operated satisfactorily for extended periods. Alternate supply for use with the vacuum chamber of Test Set 1, above.	Performed at Room Temperature previously.	Page C2
4.	Turn-off Time Test Set	800 V. pk.fwd. 100 A. peak on-state 50 A peak reverse $\frac{di}{dt}$ = 50 A/μs $\frac{dv}{dt}$ = 200 V/μs	Engineer design, order components, construct and check-out equipment.	Circuit designed and all components received. Equipment construction completed. Check-out in pro.	Test performed previously at Somerville, NJ, plant.	Page C8
5.	Repetitive Surge Current Test Set	250 A. ave.a.c. 4000 A. pk. surge 800 V. peak rev.	Engineer design of automatic 10 surge sequencing and reverse voltage supply, order components and construct equipment. Design interconnections and controls for 3 separate supplies.	Surge and Forward Current Supplies available. 90% of sequencing and rev. voltage components received. Equipment construction is in pro.	Surge current tested previously without reverse voltage at RCA. Reverse blocking tests were also performed at a customer's lab.	Page C9

TABLE I (Continued)

ELECTRICAL TEST EQUIPMENT SURVEY (Continued)

Description	Ratings	Equipment Modifications Required	Status of Equipment	Remarks	Block# Diagram
6. Thermal Impedance Test Set	12 V.D.C. 250 A.D.C. 4 A.D.C Metering	Upgrade for Pilot Production	Engrg. Test Facility available. Upgrading completed and operated satisfactorily for several devices.		Page C11
7. Exponential Rate of Voltage Rise Test Set	800 V. peak 200 V/µs 60 Hz	To be upgraded to MM&TE and electrical safety requirements.	Engrg. test facility and temp. controlled oven of Test Set 1, above, available. Upgrading completed and operated satisfactorily.	Test performed at Somerville, NJ plant.	Page C3
8. Forward On-State Test Set	6 v.a.c. 250 A. ave. 60 Hz	Instrumentation and cooling to be added to portable supply.	Power Supply and -25°C environmental chamber available. Instrumentation and cooling system completed. Equipment operated satisfactorily with several devices.		Page C4
9. Holding Current Test Set	6 v.d.c. 1 A.dc.	Upgrade for Pilot Production	Engineering test facility available. Upgraded for pilot production and operated satisfactorily.	Breadboarded previously	Page C7
10. Thermal Fatigue Test Set	12 v.a.c. 250 A. avg. 60 Hz 2 positions	Power supply available but recycling timer, instrumentation, and temperature controls must be replaced.	Components selected, ordered and received per para. J.42. Modifications completed and equipment operated satisfactorily with two devices for over 200 cycles.	Equipment use for J-15372 Thermal Fatigue Test terminated in Jan. 1977 @ 70,000 cycles.	Page C10

#Refer to Appendix C of the First Quarterly Report covering the period 27 Sep. 1976 to 31 Dec. 1976.

TABLE 2

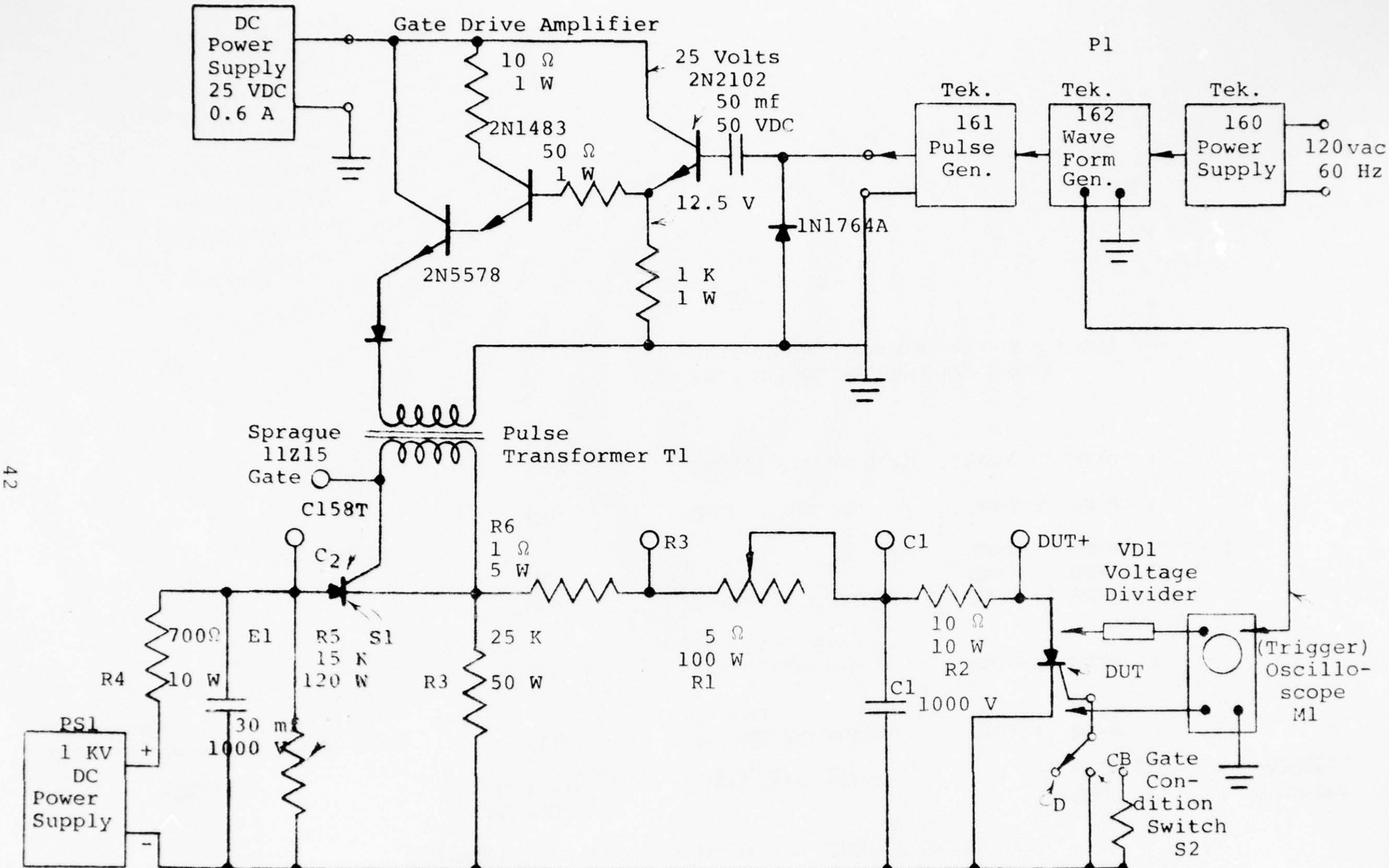
ELECTRICAL TEST EQUIPMENT INSPECTION SCHEDULE

Test Set	MIL-STD-750B Test Method	Test Description	Required Inspections	Tests per Device
Blocking Current	1001.1	Barometric Pressure (reduced)	Group C, Subgr. 3	1
Blocking Current	4206.1	For. Blocking Current, A.C. method	Group A, Subgr. 2 & 3 Group B, Subgr. 1, 3 & 4 (twice) Group C, Subgr. 2, 3 & 4	10
Blocking Current	4211.1	Rev. Block. Current, A.C. method	Group A, Subgr. 2 & 3 Group B, Subgr. 1, 3 & 4 (twice) Group C, Subgr. 2, 3 & 4	10
Gate Trigger Voltage or Current	4219	Rev. Gate Current	Group B, Subgr. 1	1
	4221.1	Gate Trigger Voltage or Current	Group A, Subgr. 3 & 4 Group B, Subgr. 2 Group C, Subgr. 2,3 & 4	7
Blocking Voltage Life Test	Para. 4.6.1	Blocking Voltage Life Test	Group B, Subgr. 4	1
	Alternate 1001.1	Barometric Pressure (reduced) (reduced)	Refer to "Blocking Current" above)	-
Other Electrical Test Equipment -	4224	Pulse Ckt. Commutated Turn-Off Time	Group A, Subgr. 4	1
Separate Test Set for each method.	4066.2	Surge Current	Group B, Subgr. 1	1

TABLE 2 (Continued)

ELECTRICAL TEST EQUIPMENT INSPECTION SCHEDULE (Continued)

Test Set	MIL-STD-750B Test Method	Test Description	Required Inspections	Tests per Device
Other Electrical Equipment (continued)	3151	Thermal Resistance, General	Group C, Subgr. 5	1
	4231.2	Exponential Rate of Voltage Rise	Group A, Subgr. 3	1
	4226.1	Forward "ON" Voltage	Group A, Subgr. 4 Group B, Subgr. 2 Group C, Subgr. 2, 3 & 4	5
	4201.2	Holding Current	Group A, Subgr. 4	1
	Para. 4.6.2	Thermal Fatigue Test	Group C, Subgr. 4	1
		Total Electrical Tests per Device (with sample sizes per para. 4.4 & 4.5)		41



Note: Identifying symbols are consistent with the block diagram, page C3, in the First Quarterly Report.

Figure 11. Exponential Rate Voltage Rise (dv/dt) Test Circuit Diagram

The maximum single-cycle surge rating on the type C158T SCR used as S1 in this equipment is 1,600 amperes, but the maximum short-pulse, multiple surge rating at the lowest repetition rate is only 300 amperes! This reduced value is undoubtedly necessary to limit the di/dt rate at turn-on to a safe value. Thus, it is not possible to achieve the required high dv/dt rate by charging a one microfarad capacitor through a C158T SCR without exceeding the repetitive surge current rating of the SCR.

The C158T was selected for this circuit because of its fast turn-on time (2μs), high blocking voltage (900 V), very high di/dt rate (800 A/μs) and good pulse characteristics ratings. Larger SCRs, such as the C180T, have higher surge current ratings but too slow a turn-on time (8μs), too low a di/dt rate (75 A/μs) and no published pulse characteristics ratings. Limiting the di/dt rate would restrict the dv/dt rate to less than the required value. Thus the C158T is believed to be the best choice for this test set.

The current limitation becomes apparent from the transient current equation for charging a capacitor, such as C1, through a resistor, R1.[1]

$$i = \frac{E}{R_1} \epsilon - \frac{t}{R_1 C_1} \qquad (1)$$

where: i is the instantaneous current through the switch, S1,
E is the supply voltage, V_{AA}, across E1, and
t is the time after the closing of the switch, S1.

For times of both zero and one-half microsecond, a voltage of 800 volts, a resistance, R_1, of 1.8 ohms and a capacitor, C_1, of one microfarad; the current, i, is calculated, as follows:

$$i = \frac{800}{1.8} \epsilon^{-(1/1.8 \times 1 \times 10^{-6})t}$$

@t = 0 μs, i = 444 amperes initial surge
@t = 0.5 μs, i = 337 amperes after one-half microsecond

The value of 1.8 ohms is believed to be representative of the internal resistance of S1 during initial conduction plus the internal resistance of the capacitors and the wiring resistances. E1 operates as an infinite source during the dv/dt pulse interval and thus a constant voltage of 800 volts can be assumed.

The voltage rate of charge on C1 is also the voltage applied to the Device Under Test (DUT) in Figure 11. This voltage can be calculated from the following equation.[1]

$$e_{c1} = -E \left(e^{-\frac{1}{R_1 C_1} t} - 1\right) \qquad (2)$$

where: e_{c1} is the instantaneous voltage charge on C1, and the minus sign signifies a polarity reversal from the applied voltage, that is, a voltage bucking E1.

For the same values used above, plus a third time interval of 1.8 microseconds, the voltage is calculated below.

@t = 0 μs, e_{c1} = 0 volts initial charge.

@t = 0.5 μs, e_{c1} = 194 volts after one-half microsecond

@t = 1.8 μs, e_{c1} = 505.6 volts, 63.2% of the peak value.

The dv/dt (by the definition in MIL-STD-750B, Method 4231) is this 63.2% voltage value divided by the time, t, to achieve 505.6 volts. Thus, the 505.6 volts divided by the 1.8 microseconds is a rate of 280 volts per microsecond. This rate for the test equipment with C1 alone connected must also allow for the added capacitance of the DUT to be paralleled with C1 (which will reduce the dv/dt rate).

[1]Skilling, H. H., Transient Electric Currents, McGraw-Hill Book Co., Inc., 1937.

To operate reliably with the available C158T SCR, it has become necessary to add resistor R6 in the figure. This establishes the minimum series resistance of about 2.8 ohms total when R1 equals zero ohms. Substituting 2.8 ohms in equations (1) and (2) above, the new peak surge current and dv/dt rate can be determined for a C1 of one microfarad.

@t = 0, i = 286 amperes initial surge.

$@e_{c1}$ = 505.6 V, t = 2.8 μs rise time.

$$\frac{dv}{dt} = \frac{505.6}{2.8} = 180.6 \text{ v/}\mu\text{s}.$$

This value of dv/dt is obviously inadequate. A further circuit refinement was thus necessary. The value of C1 was reduced to 0.1 microfarad, the initial surge of current was unchanged but dv/dt values were well in excess of the required 200 volts per microsecond. The equipment can now be used for testing the initial engineering sample devices.

The average current through S1 can also be calculated at the 60 Hertz repetition rate by integrating the current, i, in equation (1) with respect to the time, t, and dividing by the period, T.

$$I_{av} = \frac{1}{T}\int_o^T i\,dt$$

$$= \frac{1}{T}\int_o^T \frac{E}{R_1}\epsilon^{\frac{-t}{R_1C_1}}\,dt$$

$$= \frac{EC_1}{T}\left(\epsilon^{\frac{-T}{R_1C_1}}-1\right);\quad T = \frac{1}{\text{rep. rate}} \qquad (3)$$

Substituting, $T = \frac{1}{60}$ second, E = 800 volts, R_1 = 2.8 ohms and C_1 = 0.1 microfarad, the value of the average current is found to be a very low five milliamperes. The dissipation will be correspondingly low. Thus the repetive peak current of S1 becomes the limiting parameter in this circuit to achieve the required dv/dt rate.

A replacement C158T SCR has operated for several hours under these revised conditions with no deterioration. It should be noted that the reduced value of C1 actually increases the severity of the test conditions applied to the DUT, as well as provides for the higher reliability of the test equipment by reducing the surge currents and pulse durations through S1 to less than the maximum rated values. Thus, it is planned to use the dv/dt equipment with this modification until a suitable higher rated SCR can be secured to withstand the higher surge currents caused by a one microfarad capacitor, C1.

(c) Repetitive Surge Current Test Set

The equipment, designed to meet the conditions of method 4066.2 of the repetitive surge current test, is operational and the feasibility and ease of measurement was determined. The first requirement of this test is to elevate the thyristor junction to normal operating temperatures by applying a forward average current of 250 amperes. After a preset heating time to achieve thermal equilibrium, a surge current of 4000 amperes peak supplants the heating current for one-half cycle of the 60 Hz supply. On the next one-half cycle (the negative half or reverse voltage cycle) an adjustable high voltage is applied to test the device for recovery of reverse blocking after the surge of current.

This reverse voltage supply is adjustable from 100 to 600 volts rms or to approximately 850 volts peak. The range can be extended to 1600 volts peak with an internal tap change. The supply has an internal impedance of 600 ohms in series with a sensing relay to detect if the thyristor under test fails to block. The sequence of current and voltage applications requires that these supplies be properly phased and that the surge as well as the reverse voltage be initiated at a zero voltage cross-over point in the proper sequence.

The "one shot" surge circuit is shown in Figure 12.[2] With the polarity of line voltage shown,

[2] General Electric, SCR Manual, Fifth Edition, 1972, Syracuse, NY, page 202.

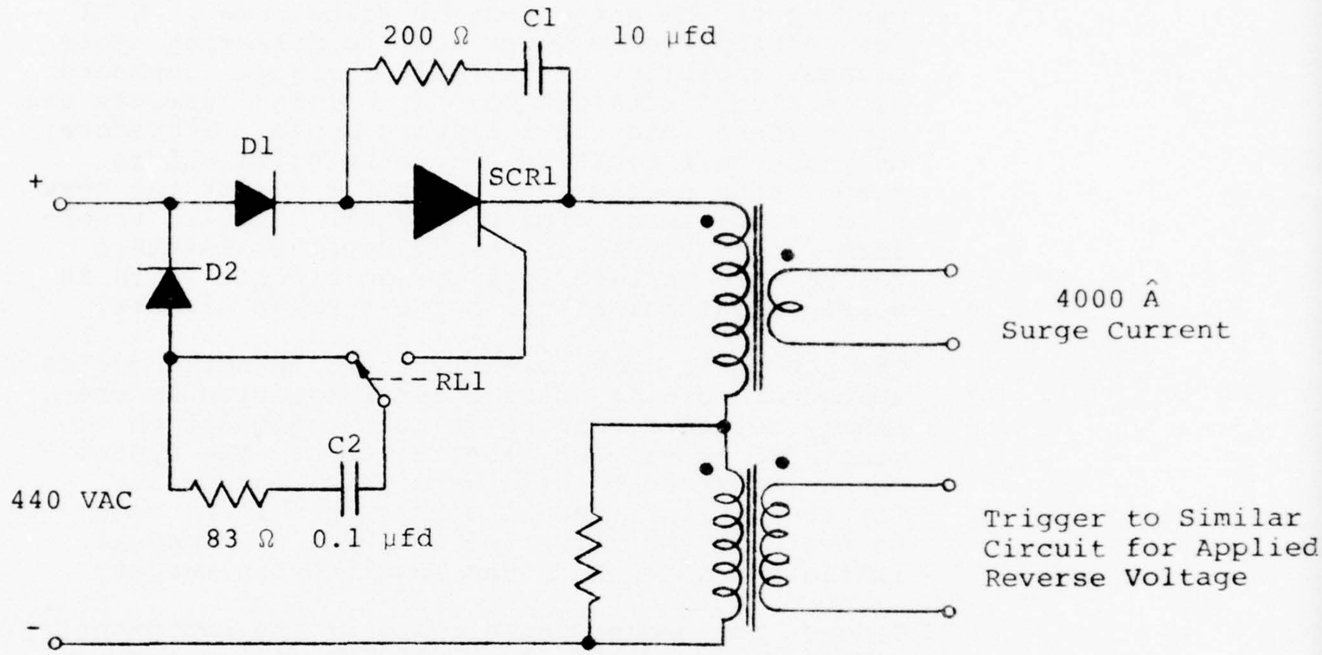


Figure 12. "One Shot" Surge Current Circuit

diode D1 charges C1 to the peak line voltage. With the closure of the "surge on" relay, RL1, SCR1 is triggered on any portion of a reverse voltage cycle by charge currents through diode D2 and capacitor C2. SCR1 then begins discharging capacitor C1 and the RC time constant is such that SCR1 remains in conduction for the next positive one-half cycle applying power to the primary winding of the surge current transformer. SCR1 does not have gate power for the following cycle because capacitor C2 is fully charged. Capacitor C1 is also discharged so that holding currents are not present into the following cycle. Therefore, only one-half cycle is completed until RL1 is reset, thus discharging capacitor C2 for the next surge requirement a minute later. A pulse transformer is included in this circuit to initiate the reverse voltage application circuit which is nearly identical to the surge current circuit.

The automatic test feature, i.e., 10 surge cycles spaced one minute apart after initiation is presently not used because of relay oscillation generated by varying closure times. The system can be modified to eliminate this problem but for the present, manual operation will be used to evaluate the first few devices, with manual initiation of each of the required ten surges.

To test for proper functioning of the equipment, a Transcalent diode, Type J15378, with a maximum inverse voltage rating of 200 volts for this particular sample, was operated in the test socket for approximately 24 forward current surges, 30 seconds apart, from 3000 peak amperes graduating to 7000 peak amperes on the final data point. With each surge 150 to 192 volts of peak reverse voltage was applied without failure of the device. A 250 amperes heating current was applied initially and maintained between surges.

To test the phasing of the gate trigger of the device under test, a 2N4103 thyristor (TO-3 case) was installed which is rated at 8 amperes average, 200 amperes surge and 600 volts inverse blocking.

This device shorted after four 1800 amperes surges and 400 volts inverse. This small device held-up well considering the average heating current was maintained at 25 amperes between the one minute spaced surges. The equipment was judged to be ready for testing a Transcalent SCR.

A J15371 SCR (engineering sample), which demonstrated high leakage currents above 200 volts inverse, was tested. The heating current was set at 250 amperes average and the unit was surged at 4000 amperes peak for twelve cycles. The device failed to block when the inverse applied voltage exceeded 170 peak volts (as expected). The inverse voltage was set at 160 volts for a large percentage of the surges and the device blocked satisfactorily.

It was noted during the tests that when the heating current was operated at the specified 250 amperes average (as read by an analog meter), that the corresponding peak value was 900 amperes (as read from a resistor-oscilloscope combination). From the calculation of the base width, t_o, of a cosine pulse train (rectified) of period, T, the ratio is given[3] as:

$$\frac{to}{T} = \frac{\pi}{2}\ \frac{Aav}{Apeak} = \frac{\pi}{2}\ \frac{250}{900} = \frac{1}{2.29} = 0.436 \quad (4)$$

or a conduction angle of 157 degrees instead of 180 degrees applies to the system. This corresponds to 7.27 milliseconds of conduction. This conduction angle means the rms current is actually higher than anticipated and can be calculated approximately by the following equation:

$$\frac{Arms}{Aav} = \frac{\pi \sqrt{\frac{to}{T}}}{2\sqrt{2}\ \frac{to}{T}} = 1.11\sqrt{\frac{T}{to}} \quad (5)$$

Substituting from equation (4) yields the following RMS current values:

$Arms = 250\ (1.11\sqrt{2}) = 393$ A (for 180^{o} conduction)

$Arms = 250\ (1.11\sqrt{2.29}) = 420$ A (for 157^{o} conduction)

This latter value represents about a seven percent increase over the theoretical RMS current and will increase the severity of the test since the RMS current is the heating value that produces the elevated junction temperatures prior to each surge.

3 ITT, Reference Data for Radio Engineers, (4th Ed.), 1956, New York, NY, Pg. 1022

Additional work to be performed in the next report period will be to verify the calibration of the meters and the peak reading system as well as to revise a portion of the circuit wiring to incorporate the automatic recycling feature. The latter revision will enable the unattended operation of this test equipment on future devices with a corresponding savings in testing labor.

d. Conclusions

The process, equipment and tooling have been designed, fabricated and checked-out on the engineering sample parts and assemblies. The through-put of some equipment will be increased in the confirmatory sample phase to facilitate the pilot run. Yields have been improved where high scrap was produced.

The modified processes, tooling and equipment described above are expected to produce and evaluate five satisfactory engineering sample devices in accordance with SCS-477 and paragraph F.47. Any additional limitations that become evident during the production of these engineering samples will be corrected in the confirmatory sample phase.

e. Drawings and Photographs of Tooling and Equipment

Copies of the drawings of the special tools and fixtures that have been modified are included in Appendix B. Photographs were included above, adjacent to the text references, for the fixtures discussed in detail in the text.

Drawings of the jigs and fixture designs were included in Appendix B of the First Quarterly Report. Any major revisions to these drawings have been included in Appendix B of this report.

Testing procedures for the electrical test equipment are included in Appendix C. Circuit diagrams were included as Functional block diagrams in Appendix C of the First Quarterly Report.

3. Flow Chart of Manufacturing Process Yield

Manufacturing process yields are to be determined during the Pilot Run.

4. Equipment and Tooling Costs

This requirement is not generally applicable to a Firm Fixed Price Contract on equipment and tooling that is furnished by the vendor.

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5. Data and Analysis

a. Inspections

Group A, B and C Inspections as specified in SCS-477 were begun during the report period on the first three engineering sample devices. The minimum acceptance criteria are those specified in Section F.47 of the contract, as follows:

TABLE I - GROUP A INSPECTION

Subgroup 1	Visual and Mechanical Inspection
Subgroup 2	Forward Blocking
Subgroup 3	Forward Blocking Current
Subgroup 4	On-State Voltage and Holding Current

All engineering test samples will be tested for compliance with Section 3 in accordance with Section 4 of SCS-477.

To date, all mechanical, most electrical and some environmental tests have been completed on one or more of the initial devices. Actual results are listed on the Test Data Record Forms, Table 3a, b, c & d.

The sequence of testing was modified, as required to utilize each piece of equipment as it became available. Effects on the validity of the results were considered in each case so that subsequent tests would not be impaired. Also, in many cases, additional engineering data was secured to guide controls and refinements to be incorporated in the subsequent Confirmatory Sample phase.

(1) On-State Voltage - Method 4226

The on-state voltage test (Table I, Group A Inspection, Subgroup 4) is an example of an inspection during which additional engineering data was secured. The values of peak on-state voltage, V_{FM}, for various average currents, I_F, of device Serial No. N2 are plotted in Figure 13. The test conditions at the 250 amperes point are those of SCS-477, namely, a frequency of 60 Hertz, a conduction angle of greater than 160 degrees, a heat sink (heat-pipe) temperature of 100° Celsius, forced air cooling flow of less than 150 cubic feet per minute and an ambient temperature of 25 $\pm$ 3° Celsius. The measured value of V_{FM} under these conditions was 1.33 volts, well within the specified maximum value of 2.0 volts.

Table 3a. Test Data Record Forms

ITEM: SILICON TRANSCALENT THYRISTOR, J15371 | CONTRACT: DAA B07-76-C-8120 | Page 1 of 4

SPEC: SCS-477 5 DECEMBER 1974 & | MFR: RCA (EO&D) LANCASTER, PA.

AMENDMENT - 1 31 AUGUST 1976 | BUYER: COMM.SYS.PROCUREMENT BRANCH (USAECOM),FT.MONMOUTH,N.J.

GROUP	A											
SUBGROUP	1	2	2	4	4	4	3	3	3	3	4	4
NO. UNITS TESTED	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
TEST	Visual & Mech.	Reverse Current	Forward Blocking	Gate Trig. V	Gate Trig. I	Holding Current	Reverse Current	Forward Block'g	Gate Trig. V	Exp. Rate V Rise	Turn-off Time	On State Voltage
MIL-STD-750 METHOD	2071	4211	4206	4221	4221	4201	4211	4206	4221	4231	4224	4226
TEST CONDITION	Visual Inspt.	25°C →					125°C →				25°C →	
SYMBOL	-	i_{RBOM}	i_{FBOM}	V_{GT}	I_{GT}	I_H	i_{RBOM}	i_{FBOM}	V_{GT}	dv/dt	t off	V_{FM}
MAX.	-	15mA	15mA	5Vdc	500mAdc	500mAdc	60mA	60mA	5.0Vdc		150µs	2.0V
MIN.	-									200V/µs		
1st Qtr., 1977 Date Tested / UNIT NO.	A R / C E / C J											
N1	✓	0.3	0.4	1.1	545	4	53	75	0.5	295*		1.3
N2	✓	0.2	0.3	1.1	620	4	40	>72	0.5	265*		1.3
N3	✓	0.3	0.3	1.0	535	4	70	>64	0.5			1.2

*Initial test performed at $T_A = 25 \pm 3°C$.

Note: Details of test conditions are given in spec.

Table 3b

CONTR'S. TYPE: J15371 | DATE TEST COMPLETED: | SAMPLE NOS. Page 2 of

MFR'S. TYPE: J15371 | DATE TEST BEGUN: | FR. TO

B													
1	1. Final Measurements			2			3. Final Meas.		4. Final Measurements				
10%	10%	10%	10%	100%	100%	100%	10%	10%	10%	10%	10%	10%	
Surge Current	Reverse Current	Forward Block'g	Rev. Gate Current	Gate Trig. V	Gate Trig. I	On-state Volt.	Temp. Moist	Cycle & Resist	Blocking per para.	Voltage 4.6.1	Life	Test	
4066	4211	4206	4219	4221	4221	4226	1051	1021	4211	4206	4211	4206	
→ 25°C	25°C →		→	-25°C →		→	4211	4206 →	25°C →	→	125°C →	→	{case temp, T_C
I_{FM}	i_{RBOM} 15mA	i_{FBOM} 15mA	I_{GR} 1.0Adc	V_{GT} 10Vdc	I_{GT} 1000 mAdc	V_{FM} 2.3V	i_{RBOM} 15mA	i_{FBOM} 15mA	i_{RBOM} 15mA	i_{FBOM} 15mA	i_{RBOM} 60mA	i_{FBOM} 60mA	
10 Surges													
N1				1.3	760	1.5							
N2				1.4	880	1.7							
N3				1.3	720	1.5							

Table 3c

GROUP	C									
SUBGROUP	1					2.Final Measurements				
NO.UNITS TESTED	100%	100%	100%	100%	100%	10%	10%	10%	10%	10%
TEST	Physical Dimens.					Shock,	Vibration,	Constant	Accel.	
MIL-STD-750 METHOD	2066					2016	2056	2006		
TEST CONDITION	Figure 1					4211	4206	4221	4221	4226
SYMBOL	A	B	C	D	E	i_{RBOM}	i_{FBOM}	V_{GT}	I_{GT}	V_{FM}
MAX.	5.00"	3.475"	0.700"	1.857"		20mA	20mA	5Vdc	500mAdc	2.5V
MIN.		3.425"	0.600"		6.00"					
UNIT NO.								For information only - Not a spec. requirement		
N1	4.81	3.468	0.668	1.815	8.75					
N2	4.76	3.442	0.669	1.821	8.75					
N3	4.80	3.470	0.677	1.807	8.75					

Table 3d

	3. Final Measurements					4. Final Measurements					5	
	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	100%	
	Reduced Barometric Pressure					Salt Atmosphere, Thermal Fatig.					Thermal Resistance	
	1001					1041	para.	4.6.2			3151	
	4211	4206	4221	4221	4226	4211	4206	4221	4221	4226		
	i_{RBOM}	i_{FBOM}	V_{GT}	I_{GT}	V_{FM}	i_{RBOM}	i_{FBOM}	V_{GT}	I_{GT}	V_{FM}	θ_{J-c}	
	20mA	20mA	5Vdc	500mAdc	2.5V	20mA	20mA	5Vdc	500mAdc	2.5V	0.15°C/Watt	
											Initial	After -25°C
57												
N1											0.19	0.39
N2	0.2	0.3	1.1	640	1.4	0.3Δ	0.3Δ	1.1Δ	640Δ	1.4Δ	0.14	0.12
						@800V.	@800V.					
N3						28.9Δ	10Δ	1.1Δ	550Δ	1.4Δ	0.15	0.12
						@500V.	@220V.					

ΔFollowing 270 cycle Thermal Fatigue Test, only.

K+E 5 x 5 TO 1/2 INCH 46 0863
7 X 10 INCHES MADE IN U.S.A.
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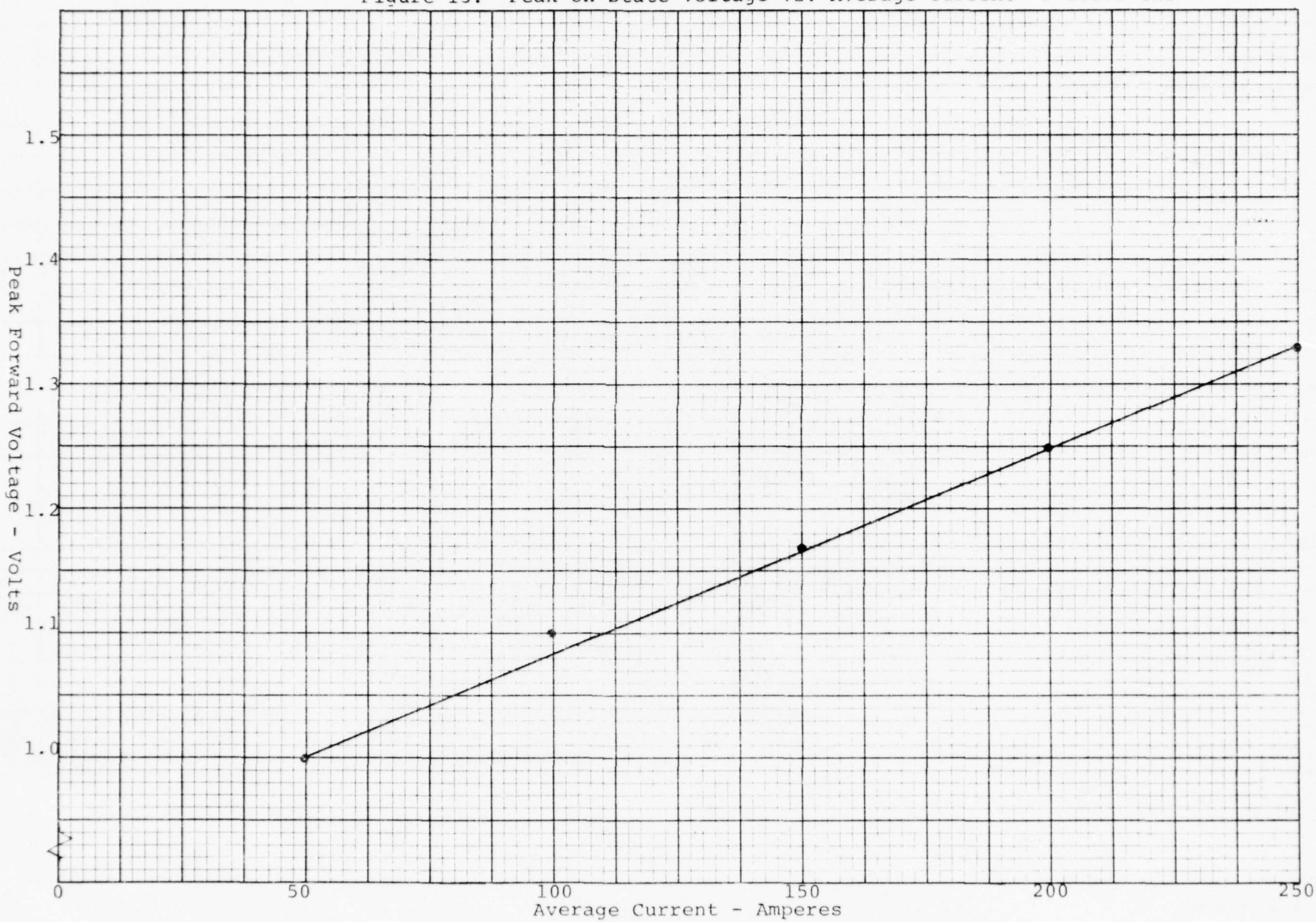
Figure 13. Peak On-State Voltage vs. Average Current J-15371 #N2



This test is one of the minimum acceptance criteria listed above for the engineering samples submitted. A more thorough evaluation was thus believed to be justified.

Figure 14 shows the variation of heat-pipe temperatures on Serial No. N2 with average currents and cooling air flows. Four temperature measurement points were utilized to verify that the heat-pipes were both balanced and isothermal. Note that the air flow had to be reduced from 82 to 73 cubic feet per minute to achieve the case temperature of 100° C at the 250 A of average current required for this inspection.

Devices No. N1 and N3, as listed in Table 3a of this report, also passed this inspection with no difficulty.

(2) Thermal Resistance - Method 3151

Another crucial inspection for Transcalent Devices is the thermal resistance (Table III, Group C, Subgroup 5). Additional engineering data was taken initially, before the -25° Celsius frozen start test and before the 200 cycles thermal fatigue test, to establish a reference value for any hidden defects that might be incurred by those latter two severe test conditions.

Thermal resistance test results for device Serial No. N2 are plotted in Figure 15 for various values of dissipation. In the figure, 250 watts of dissipation corresponds to a forward current, I_F, of 250 amperes on this particular device. This correlation of dissipation and current will vary slightly with the on-state voltage of each device.

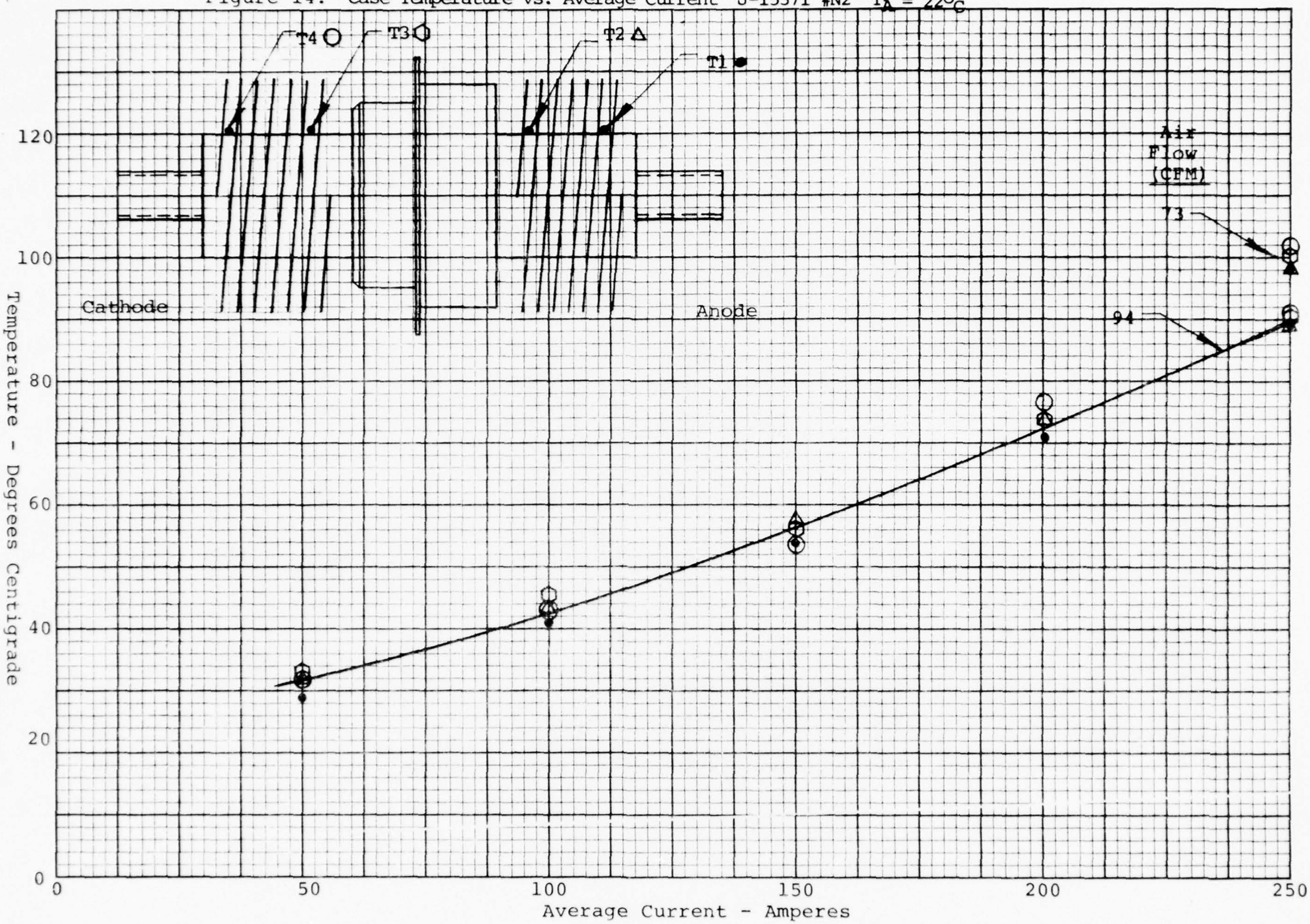
The thernal resistance, θ_{J-C}, is calculated and plotted from the following equation for each heat-pipe, anode and cathode.

$$\theta_{J-c} = \frac{T_J - T_{HP}}{P_d} \quad {}^{\circ}\text{ C/watt} \qquad (6)$$

where: T_J is the junction temperature in $^{\circ}$C previously calibrated in a temperature controlled oven at a metering current of 4 amperes,

T_{HP} is the heat-pipe temperature in $^{\circ}$C at the base of the fins, and

Figure 14. Case Temperature vs. Average Current J-15371 #N2 $T_A = 22^oC$



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K•E 10 X 10 TO ½ INCH 7 X 10 INCHES
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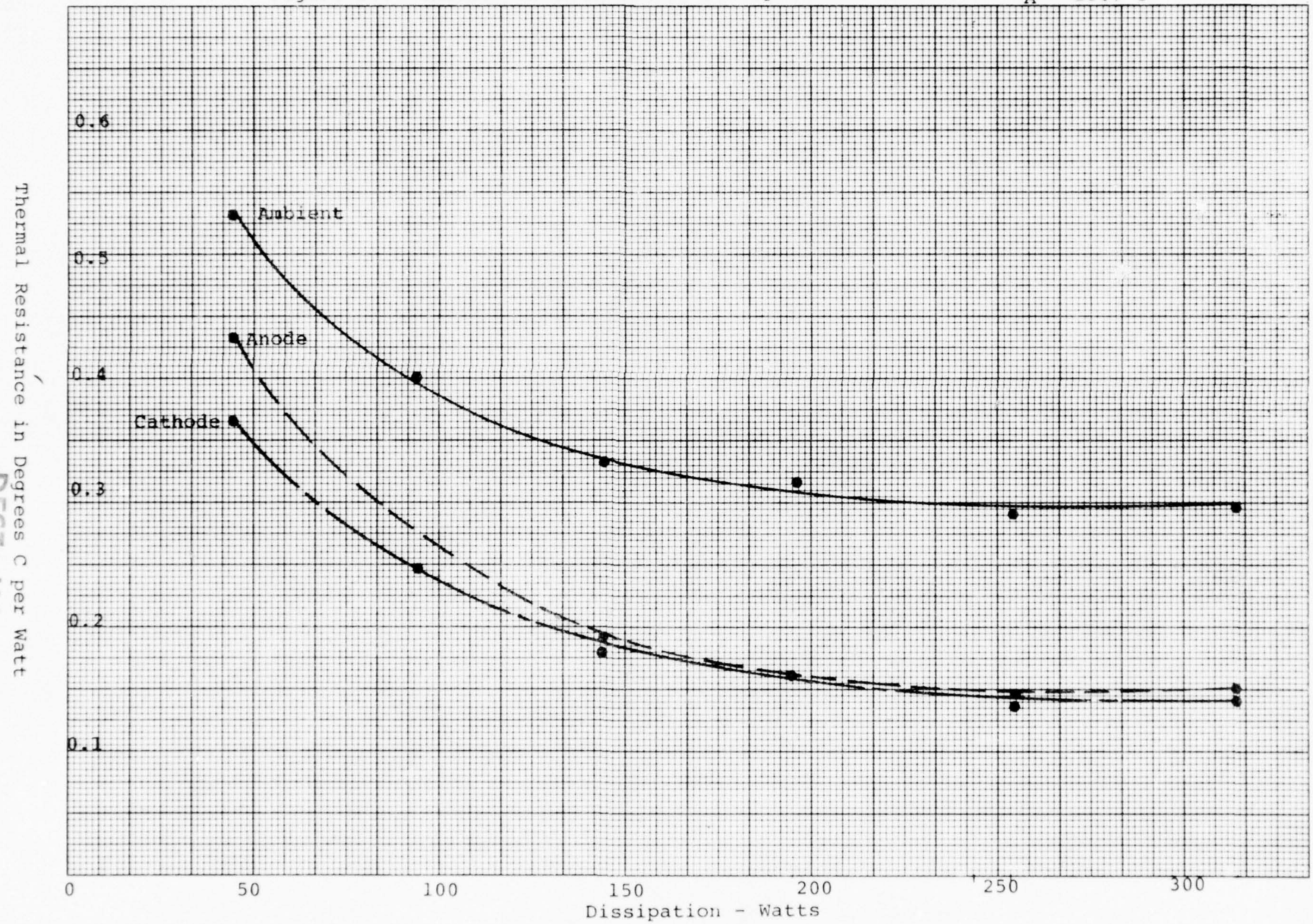
46 1323

Figure 15. Thermal Resistance vs. Dissipation J-15371 #N2 $T_A = 25.7^oC$



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P_d is the dissipation of the thyristor silicon wafer in watts, at the specified on-state forward current.

Note that both heat-pipes have a θ_{J-C} of less than the specified maximum value of 0.15 degrees Celsius per watt at 250 watts of dissipation. The average value of the two heat-pipes is listed in Table 3d.

Devices No. N1 and N3 were also measured as listed in Table 3d. Device N3 passed the specified maximum thermal resistance value but N1 did not because of unbalanced heat-pipes. An internal mechanical defect is suspected in N1. It will be analyzed after additional testing is performed.

Note that with heat-pipe cooling, the thermal impedance actually improves with increasing dissipation. This unique characteristic provides an added safety factor for overloads and for high ambient temperatures such as may be encountered by military equipment. This characteristic of heat-pipe cooling thus improves reliability. Most other coolers, consisting of solid materials, have a worsening of thermal impedance with increasing temperature, because of the decrease of thermal conductivity with temperature.

The thermal resistance of a solid state device to the ambient cooling air, $R_{\theta JA}$, was also measured, calculated from the following equation and plotted in the figure.

$$R_{\theta JA} = \frac{T_J - T_A}{P_d} \quad {}^{o}C/\text{watt} \tag{7}$$

where: T_A is the temperature in ^{o}C of the cooling air flow.

No limit on this parameter is specified in the contract but it is important as applications engineering data for future equipment designs.

b. Discussion of Inspection Results

The test results on the first three devices reveal an obvious consistency or reproducibility of the electrical, mechanical and thermal characteristics as well as a need for improvement in a few of the parameters. Specific comments, analysis and discussion of the test results are listed below by inspection subgroup in SCS-477. Refer to Table 3a, b, c and d for specifications (spec.) and actual measured values.

(1) Table I - Group A

(a) Subgroup 1

All devices are acceptable at Visual and Mechanical inspection.[@]

(b) Subgroup 2

The room temperature forward[@] and reverse leakage currents at 800 volts are well within the spec.

(c) Subgroup 3

Some improvement in the forward[@] and reverse leakage current characteristics is obviously needed at 125°C. The gate voltage is well within spec. and the dv/dt will be measured at the high temperature of 125°C during the next report period.

(d) Subgroup 4

The gate voltage, holding current[@] and on-state voltage[@] are all in spec. Only the gate current requires improvement. The turn-off time test set will be completed for measurement of the turn-off time parameter during the next report period.

(2) Table II - Group B

(a) Subgroup 1

The surge current test set will be completed and used to measure this parameter during the next report period.

[@]Minimum acceptance criteria for engineering samples.

(b) Subgroup 2

All test results at 25 degrees below zero were in spec. In addition, the thermal resistance was measured on all three devices to detect any hidden damage that might have been caused by the frozen starts. Two of the three devices tested showed no damage (refer to Table 3d). The third had its blocking voltage as well as its thermal resistance degraded by this test.

(c) Subgroup 3

These environmental tests will be performed during the next report period.

(d) Subgroup 4

Performance of this 800 volts blocking voltage life test must await the availability of additional devices with lower leakage currents at 125°C. The first three devices experience thermal runaway from the added dissipation of their high leakage currents. They will block 800 volts of ac only for limited time intervals at high temperatures. The junction temperature increases from the dissipation, thus thermally increasing the leakage current and this continues cumulatively until thermal runaway occurs and the current limiting fuse of the test set is blown-out. A maximum of 57 hours was achieved with one of the devices by reducing the oven temperature in an attempt to compensate for the internal dissipation of the device.

(3) Table III - Group C

(a) Subgroup 1

The physical dimensions are all in spec. Refer to Figure 1 for the locations of the dimensions A through E.

(b) Subgroup 2

Shock, Vibration and Constant acceleration tests will be scheduled in the next report period.

(c) Subgroup 3

One device was tested at reduced barometric pressure and there was no deterioration of the Final Measurement parameters from the initial values listed in Table 3a.

(d) Subgroup 4

Thermal fatigue was measured on two of the three devices. One degraded because the cooling air flow in this test set was inadequate and allowed damagingly high junction temperatures of 160 to 180°C to occur. This cooling deficiency has been corrected by the installation of a much larger blower.

The third device could not be tested because of the excessive thermal resistance noted in Table 3d.

Salt atmosphere tests will be scheduled in the next report period.

(e) Subgroup 5

The thermal resistance of all three devices was measured both before and after the frozen start tests. Two of the three are satisfactory. This parameter will be measured again at the completion of the inspections.

c. Corrective Action

Corrective action has been instituted to improve the high temperature, forward blocking current and the gate current values on the future engineering sample devices. These devices are expected to become available for inspection in April and May. Additional improvements will be incorporated before the confirmatory sample phase to meet any other deficiencies that may become apparent during the remaining inspections. Yields will be improved prior to the pilot run.

Transcalent Thyristor
Type J-15371, Serial No. N2:

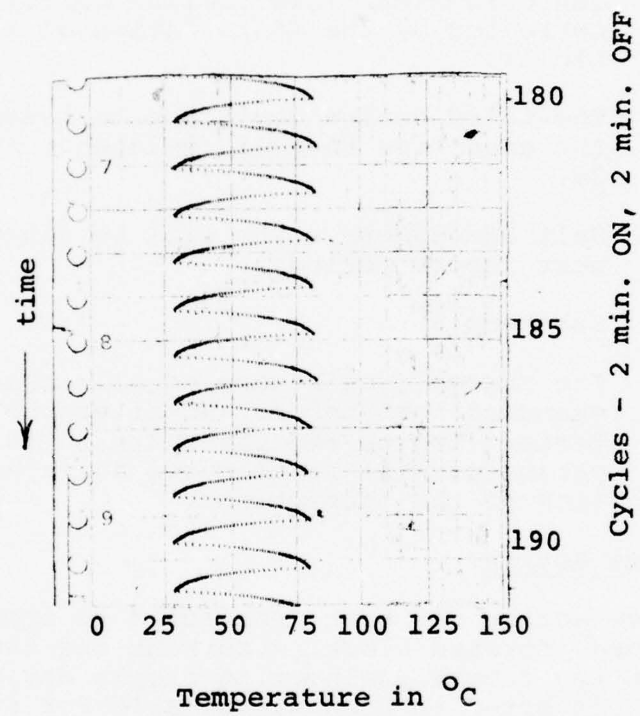

Figure 16 : Actual recording of the heat-pipe temperature excursion during the Thermal Fatigue test. Temperature specification is 30 ± 10°C min., 90 ± 10°C max.

6. Specification

The only specification change suggested at this time is the addition of a thermal resistance test in Table II, Subgroup 1. This preliminary determination of heat-pipe efficiency could then be used to detect any internal damage, or delamination that may be caused by the frozen start (-25°C) test of Subgroup 2. This added test was performed on the first three engineering sample devices, as discussed above.

7. Requirement for Pilot Run

Not applicable until later in the contract.

8. Total Cost for Pilot Run

Data not yet available.

9. Program Review

The PERT chart was revised and resubmitted to ECOM on 14 March 1977. As of 31 March 1977, the program was about six weeks behind schedule. The first Lancaster diffused devices were tested in the laboratory in February 1977 giving preliminary indications that the high temperature blocking voltages were not yet comparable to Somerville diffused devices. Heat-pipe fabrication was concluded while measures were taken to correct the difficulties, as discussed in the text. Corrosion tests and the revisions to the engineering drawings were completed. Modifications are nearing completion on the test equipment so that electrical testing can be completed in the next report period. Process record forms are in use and extensive test data has been secured on the initial devices in spite of their voltage limitations.

CONCLUSIONS

Overall it is estimated that the program was about 15% completed in the first six months of the contract. There is concern, however, that the additional time required to achieve wafers equivalent to Somerville's original quality may jeopardize the delayed delivery schedule in the next quarterly report period.

Considerable effort is being expended to correct the difficulties so that the program can be returned to schedule in the confirmatory sample phase. Considerable progress is apparent in recent diffusion lots at Lancaster that exhibited blocking voltages of 1,100 to 1,400 volts after the crucial high voltage junctions were driven into the silicon. Leakage currents, even at high temperatures, are now very low. Additional engineering sample devices will be assembled as soon as these newest thyristor wafers have completed the remaining processing and metallizing.

RCA is still confident of meeting the MM&TE specification requirements for the confirmatory sample and pilot run devices.

PROGRAM FOR NEXT QUARTER

1. Process additional silicon wafers with modified diffusion schedules for higher voltage and complete the assembly of additional engineering sample devices,

2. Perform environmental tests on the first engineering sample devices,

3. Complete the check-out of the two remaining test sets for the surge current and turn-off time tests,

4. Deliver the engineering sample devices following completion of all tests, and

5. Reissue the PERT chart to reflect the additional delays in transferring the wafer technology to Lancaster.

IDENTIFICATION OF PERSONNEL

The professional and skilled technical personnel who actually worked on the MM&TE project during the first and second quarters have varied backgrounds, as listed in the biographical resumes included in the First Quarterly Report. Three additional resumes are included in this report for added personnel assigned to the project in the Second Quarter.

In addition, numerous supporting personnel including managers, secretaries, purchasing agents, marketing specialists, machinists, electricians, experimental tube builders, etc. have contributed to the progress made in the first six months of the contract.

REVISIONS
AP. BY
DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING. DO NOT SCALE DRAWING. ALL EXTERNAL THREADS TO BE CLASS 2A BEFORE PLATING AND NOT GREATER THAN THE MAXIMUM SIZE OF CLASS 3A AFTER PLATING. ALL INTERNAL THREADS TO BE CLASS 2B UNLESS OTHERWISE SPECIFIED.
3025242Ri

C. V. Reddig, Associate Engineering Technician, Electrical and Mechanical

Mr. Reddig's education following graduation from high school in 1942 included Wyomissing Polytechnic Institute where he completed all freshman courses in 1943.

In the Air Corps from 1943 to 1946, he graduated from various schools including Scott Field, Il, in Radio and Code, Boca Raton, FL, in Radar, and Fort Myers, FL, in Gunnery.

In 1948 he completed a two-year technical program at Bliss Electronics in Washington, DC.

In 1952 at the Dellingen, Germany, Academy for Officers, he completed advanced officers' school and is presently a Major in the Pennsylvania National Guard. He is taking Army extension courses at present in the National Guard. Also, he completed an RCA Institutes TV Repair course, a basic transistor course and is presently enrolled in ICS Electronics courses.

RCA Work Experiences

He started with RCA in March, 1948 as an electrician where he gained experience in repairing various test sets for power devices.

In 1952, he was assigned to the construction and testing of large power cavities, to the H.P.L.F radar program and to the fabrication of traveling wave tubes for shipment to customers.

On assignments in the life test area, Mr. Reddig built many test positions for various tube types, including picture tubes. He designed and built many power supplies and complete equipments for tube testing and operated various test sets in the life test area to evaluate tubes.

A reassignment to the cooking tube project involved the set-up of a complete area for life testing of the triode cooking tube, the design of a simplified power supply and the construction of many of these supplies for in-house use and for sales to customers. The life testing of cooking tubes was also included in this assignment.

In a subsequent assignment to Power Tube development, he constructed and designed many equipments for the testing of medium power tubes such as types 8916, 8807, etc. He also participated in various frequency stability tests. He black-coated anodes in a vacuum system, tested developmental tubes and repaired a variety of equipments including oscilloscopes and other sophisticated facilities.

Just a short time before this present assignment, he was responsible for r.f. cavity construction and testing for sales to customers. In his latest project, he is responsible for Transcalent test set construction and checkout. Transcalent devices are a new solid state power product development in the M&P Laboratory.

Besides his employment at RCA, he operates a radio and TV repair business, is presently teaching OCS at IGMR, is Commanding Officer for five battalions in the 28th Division as well as teaches radio and radar operation and repair in the National Guard.

D. R. Trout - Member, Technical Staff

Mr. Trout joined the RCA Electron Tube Division in 1954 as an undergraduate cooperative student. He acquired thirty months of experience during this period as an Electrical Equipment Designer. Upon graduation from Drexel Institute of Technology in 1958 with a B.S. degree in Electrical Engineering, he was assigned to the Large Power Tube Equipment Development group. Here he was instrumental in the development and operation of several high-power, high-frequency test facilities. Responsibilities also included evaluation testing of product: high power triodes, tetrodes, klystrons and more recently, Coaxitrons and Transcalent solid state devices.

Mr. Trout received his M.S. degree in Physics from Franklin and Marshall College in 1974. He is presently utilizing in-plant educational programs in both technical and non-technical areas to further increase his theoretical knowledge.

Mr. Trout is a Registered Professional Engineer in the State of Pennsylvania and is a member of Sigma Pi Sigma.

Anthony J. Witkowski - Senior Engineering Technician, Electrical and Mechanical

Mr. Witkowski was graduated from Hillyer College in Hartford, CT in 1956 with an Associate of Science degree in Electronic Engineering. He has subsequently completed two company-sponsored courses in basic transistor theory and applications.

He joined the Large Power Tube Test Equipment Design group in 1959 and participated in the design of test facilities for Large Power Triodes such as the 7835 and 6950 types. He was later transferred to the Applications group and assisted in the evaluation of the design of several Large Power Tetrodes (types 2041 & 4648) and the subsequent design and development of test facilities for the above tetrodes. Extensive high current, high voltage circuit experience was gained during these assignments.

In 1974 he was transferred to the Large Power Tetrode Production Department. While there, he was involved in test and evaluation of the Large Power Tube Tetrode line. His duties there were to evaluate these tetrodes according to applicable Military Specifications and to maintain the extensive test facilities.

In 1977, he joined the Transcalent Devices Development group and has been assigned to the development and processing of the high current, high voltage transcalent SCRs for the MM&TE contract. He is involved in the refinement of the silicon wafer processes which include silicon diffusion, photoresist masking and chemical etching operations as well as the metallographic analysis of junction depths. He also constructs special equipment for use in the processing and evaluates the high voltage capabilities of the silicon wafers.

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ATTN: Mr. Art Schoenfeld
One Space Park
Redondo Beach, CA 90278

Garrett Air Research
ATTN: Mr. Everett Geis
2525 West 190 Street
Torrance, CA 90509

Airesearch Manufacturing Co.
ATTN: Mr. John Ashmore
Electronic Systems
2525 W. 190th Street
Torrance, CA 90509

Naval Underwater Systems Center
ATTN: Mr. George Anderson/Code 3642
Newport, RI 02840

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K. C. Harding
Arlington

E. Schmitt
Somerville

APPENDIX A

J-15371 Revised Parts and Assembly Drawings. Refer to the First Quarterly Report for Other Parts and assembly drawings.

(Note: Organized in numerical order by drawing number.)

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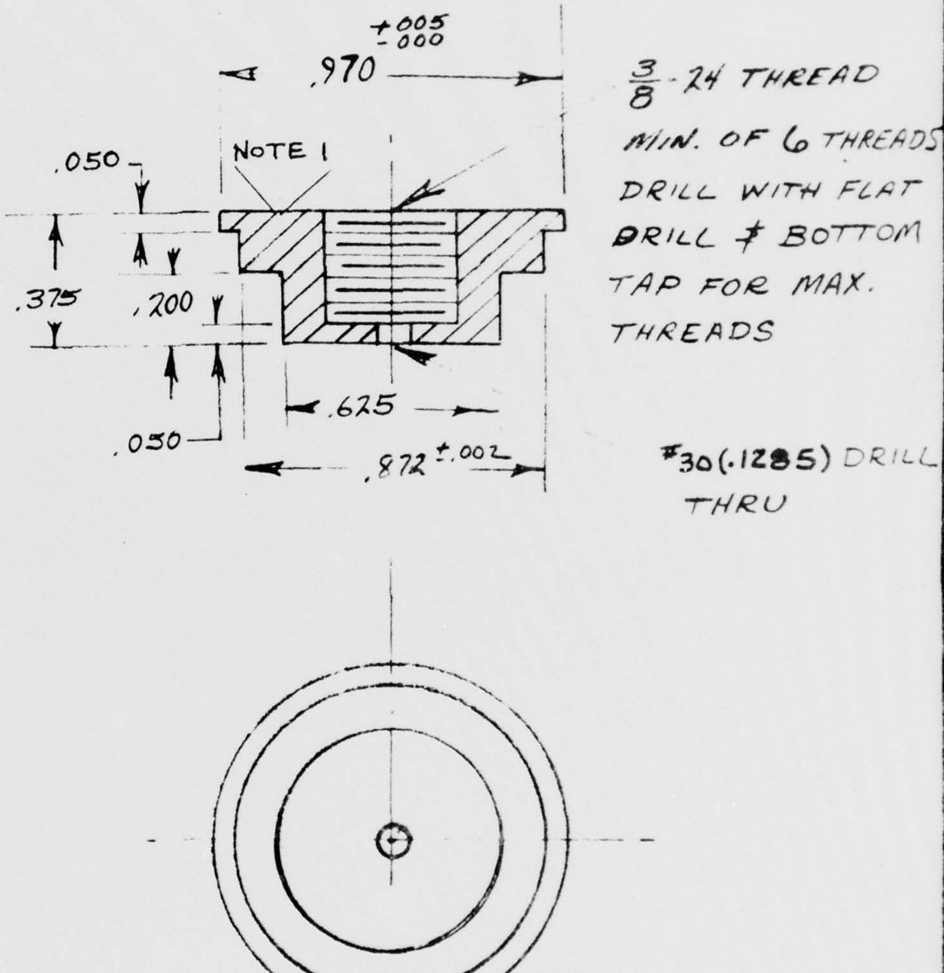
REVISIONS	
AP. BY	0
DATE	
moved OD from .950 to .970 10/20/75 [signature]	1
#30(.1285) DIA. WAS #49(.073) DIA. R. Miles 9/8/76	2
NOTE 1 ADDED WJ Burkin 2-25-77	3
MIN. OF 6 THREADS WAS 7 R. Miles May 3, 1977	4

DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING. DO NOT SCALE DRAWING. ALL EXTERNAL THREADS TO BE CLASS 2A BEFORE PLATING AND NOT GREATER THAN THE MAXIMUM SIZE OF CLASS 3A AFTER PLATING. ALL INTERNAL THREADS TO BE CLASS 2B UNLESS OTHERWISE SPECIFIED. ALL THREADS TO BE UNIFIED STANDARD SCREW THREAD SERIES UNLESS OTHERWISE SPECIFIED.

3025212R4



1. 32 MICRO INCH MACHINED SURFACE FINISH ON ALL MACHINED SURFACES

MATERIAL OFHC COPPER C 600 D
1.00" DIA X .5"/PART

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TOLERANCES AND WORKMANSHIP REQUIREMENTS NOT SPECIFIED ON THIS DRAWING SHALL CONFORM TO SPECIFICATION 93850.

BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP THRU 6		
6 THRU 24		
ABOVE 24		
ANGULAR DIMENSIONS		

RCA — RCA CORPORATION

END CAP

FIRST MADE FOR — USED ON

DRAWN BY [signature] 10/14/74

DESIGNED BY [signature] 10/14/74

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A SIZE — 3025212R4

CODE IDENT NO. 49671 — SHEET — CONT'D ON SH

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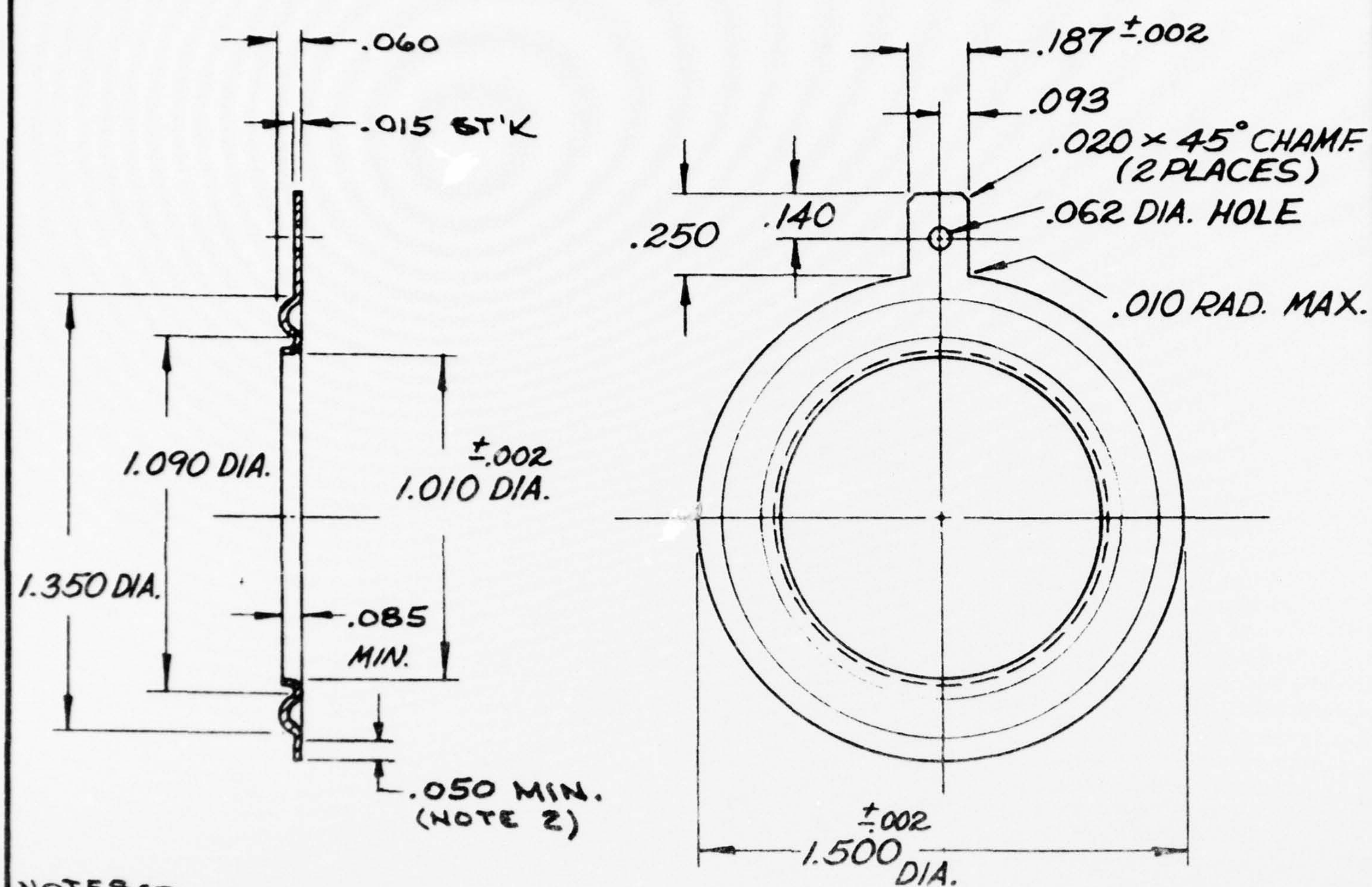

REVISIONS

CHECKED BY	
APPROVED BY	0
NOTE WAS FIRE IN LINE H_2 FOR 30 MIN. @1030°C BEFORE PLATING - NICKEL PLATE .0003-.0005 TH'K - SURFACE MUST NOT BLISTER WHEN FIRED @ 900°C IN H_2 — R. Miles Oct. 5, 1976	1
.085 MIN. WAS .050; ADDED .050 MIN. & NOTES 2 & 3 — R. Miles Jan. 19, 1977	2

NOTES:

1. FIRE IN LINE HYDROGEN FOR 30 MIN. @900°C & @1100°C FOR 10-20 MIN. (AT RCA)
2. SURFACE MUST BE FLAT WITHIN .002 T.I.R. & FREE OF TOOL MARKS & SCRATCHES
3. PART TO BE FREE OF BURRS

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STANDARD TOLERANCE			
BASIC DIM		FRAC.	DEC.
UP TO 6"	±	1/64	.005
ABOVE 6"	±	1/32	.010
ABOVE 24"	±	1/16	.015
ANGULAR DIM. ± 1/2°			

NOTE: THREADS EXTERNAL, CLASS 2A; INTERNAL, CLASS 2B (AMERICAN STDS) UNLESS OTHERWISE SPECIFIED.

SURFACE ROUGHNESS OF 500 MICRO-INCHES OR STOCK FINISH ACCEPTABLE UNLESS OTHERWISE SPECIFIED.

NOTE: SUPPLY ALL SCREWS, NUTS, BOLTS, RIVETS, WASHERS, DOWELS, TAPER PINS, COTTER PINS & WOODRUFF KEYS WITH PART.

MATERIAL: .015 THICK I6857 (KOVAR)			DWG. TITLE: CATHODE FLANGE
PATTERN NO.: 2.0 × 2.0	SCALE: 2:1	USED ON	DESIGN BY
RCA Electronic Components — EQUIPMENT DEVELOPMENT			DRAWN BY: R. FRANKHOUSER 11-20-74

MODEL NO

SIZE: A — DWG. NO. 3025225R2

REVISIONS

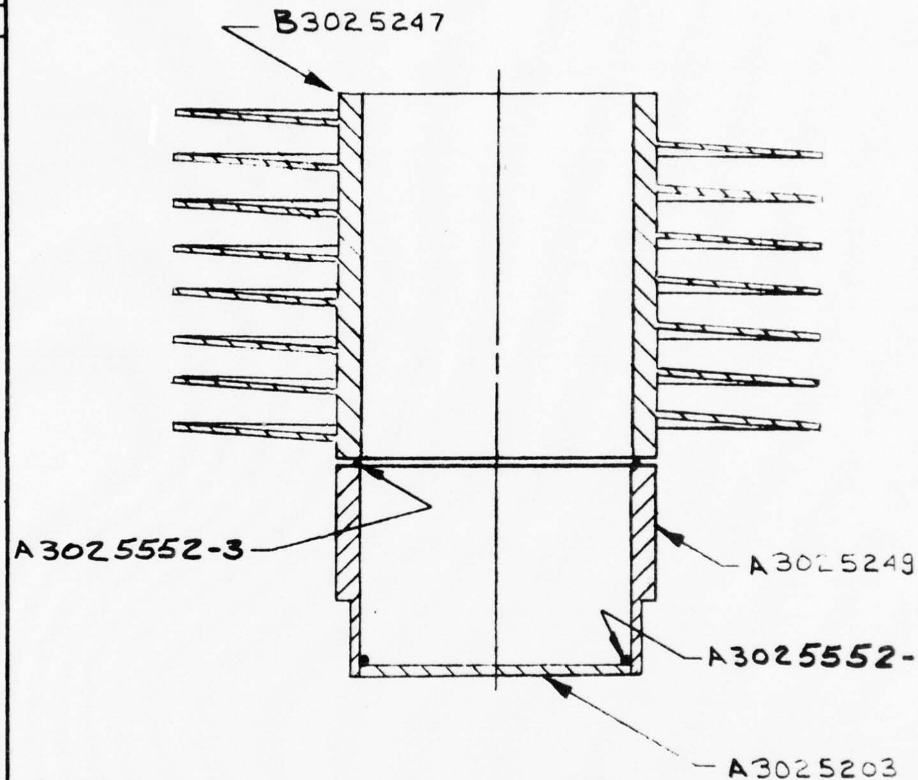
AP. BY	0
DATE	

CHANGED LOC. OF PT. #3025552-3 & ADDED "& CLEAN COP PT.'S PER SCHED. CL-1" TO NOTE 1

R. Miller Jan. 20, 1977 | 1

DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING. DO NOT SCALE DRAWING. ALL EXTERNAL THREADS TO BE CLASS 2A BEFORE PLATING AND NOT GREATER THAN THE MAXIMUM SIZE OF CLASS 3A AFTER PLATING. ALL INTERNAL THREADS TO BE CLASS 2B UNLESS OTHERWISE SPECIFIED. ALL THREADS TO BE UNIFIED STANDARD SCREW THREAD SERIES UNLESS OTHERWISE SPECIFIED.

3025242R1



NOTES:

1. VAPOR DEGREASE ALL PARTS BEFORE BRAZING & CLEAN COP PT.'S PER SCHED. CL-1
2. BRAZE @ 1020°C FOR 15 MIN. IN LINE HYDROGEN. USE FIXT. #B3025254

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TOLERANCES AND WORKMANSHIP REQUIREMENTS NOT SPECIFIED ON THIS DRAWING SHALL CONFORM TO SPECIFICATION 93050.

BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP THRU 6		
6 THRU 24		
ABOVE 24		—
ANGULAR DIMENSIONS		

RCA — RCA CORPORATION

CATHODE BODY SUBASS'Y

FIRST MADE FOR — USED ON

DRAWN BY W. T. BURKINS

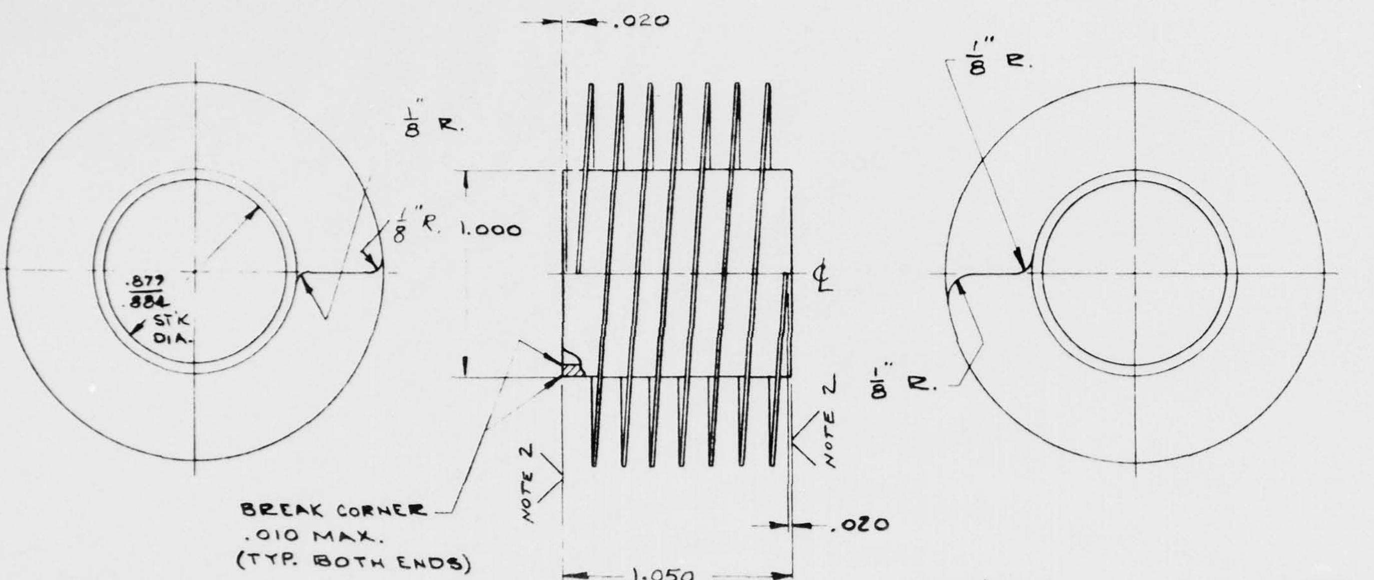
DESIGNED BY

CHECKED BY

COMMODITY CODE

A SIZE — 302 5242R1

CODE IDENT NO. 49671 — SHEET — CONT'D ON SH



NOTES:

1. TRIM OFF .020 FROM EACH END TO REMOVE THE DAMAGED END OF FIN, LEAVING A MINIMUM OF 7 FULL FINS. IT IS NOT NECESSARY THAT THE ENDS OF THE FINS BE ALIGNED
2. 32 MICROINCH FINISH - SURFACE MUST BE PERPENDICULAR TO CENTER LINE
3. CLEAN WITH CHEM POLISH 14 PRIOR TO ASS'Y; PER SCH. CL-1

MAT'L: 61-0714065-01 WOLVERINE COPPER TRUFIN TYPE H/A TUBING - EXTRUDED WITH 7 FINS/INCH - RANDOM LENGTHS TO 20 FT. LG.

REVISIONS

CHECKED BY

APPROVED BY

0 — REDRAWN FROM A3025247; ADDED END VIEWS & NOTE 2

1 — R. Miles Jan. 27, 1977. Changed note 1, added note 2, changed .070 to .020, added 1/8" R

2 — W. Burkin 2-22-77. 1.050 WAS 1.100

3 — R. Mi... ...22, 1977. CHANGED ALL RADII TO 1/8"

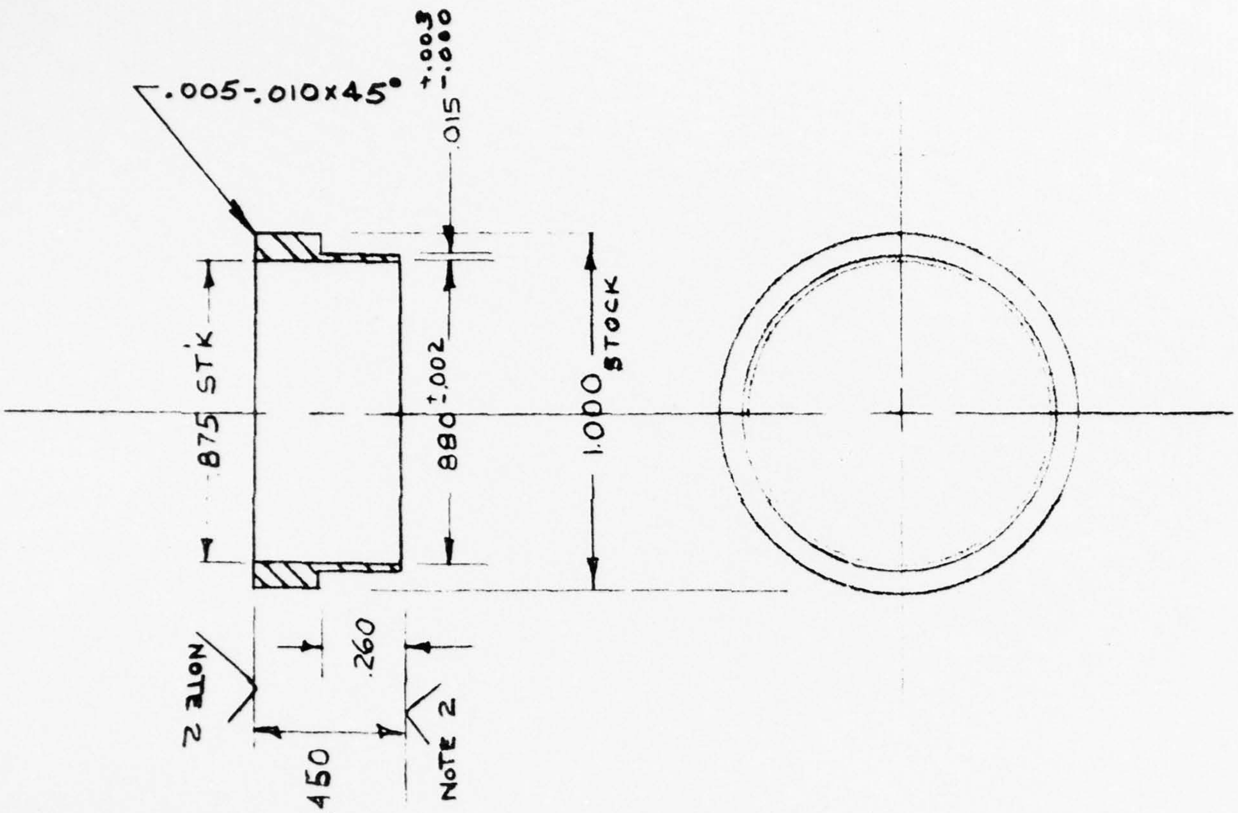
4 — R. Miles May 3, 1977

THESE DRAWINGS AND SPECIFICATIONS ARE THE PROPERTY OF RADIO CORPORATION OF AMERICA AND ARE NOT TO BE REPRODUCED OR COPIED OR USED AS THE BASIS FOR THE MANUFACTURE OR SALE OF APPARATUS AND/OR DEVICES WITHOUT PERMISSION

STANDARD TOLERANCE				NOTES	MATERIAL			DWG. TITLE		
BASIC DIM.		FRAC.	DEC.	NOTE: THREADS EXTERNAL, CLASS 2A; INTERNAL, CLASS 2B (AMERICAN STDS) UNLESS OTHERWISE SPECIFIED.	SEE ABOVE			FINNED TUBING		
UP TO 6"	±	1/64	.005	SURFACE ROUGHNESS OF 500 MICRO-INCHES OR STOCK FINISH ACCEPTABLE UNLESS OTHERWISE SPECIFIED.	PATTERN NO.	SCALE 2:1	USED ON	DESIGN BY	MODEL NO. J15371C	
ABOVE 6"	±	1/32	.010							
ABOVE 24"	±	1/16	.015	NOTE: SUPPLY ALL SCREWS, NUTS, BOLTS, RIVETS, WASHERS, DOWELS, TAPER PINS, COTTER PINS & WOODRUFF KEYS WITH PART	RADIO CORPORATION OF AMERICA — EQUIPMENT DEVELOPMENT			DRAWN BY S.W. KESSLER 4/2/76	SIZE B	DWG. NO. 3025247R4
ANGULAR DIM.	±	1/2°								

T 880 12/58

DEFIANCE NO 1080F-8 470



NOTES ~
1. CLEAN WITH CHEM POLISH 14, PRIOR TO ASS'Y, PER SCHED. CL-1
2. ENDS PERPENDICULAR TO ℄
3. 32 MICROINCH MACHINED SURFACE FINISH

REVISIONS	
CHECKED BY	
APPROVED BY	0
Changed .015 +.005 -.000 to .015 +.003 -.000 W J Burkins 5-3-76	1
Changed .410 to .400 W J Burkins 7-12-76	2
ADDED .005-.010 x 45°; .015 WAS +.005 -.000 R. Miles Sept. 17, 1976	3
ADDED NOTE 1 R. Miles Jan. 20, 1977	4
Changed .400 to .450 W J Burkins 2-23-77 added 2	5

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STANDARD TOLERANCE			
BASIC DIM		FRAC.	DEC.
UP TO 6"	±	1/64	.005
ABOVE 6"	±	1/32	.010
ABOVE 24"	±	1/16	.015
ANGULAR DIM. ± 1/2°			

NOTE: THREADS EXTERNAL, CLASS 2A; INTERNAL, CLASS 2B (AMERICAN STDS) UNLESS OTHERWISE SPECIFIED.

SURFACE ROUGHNESS OF 500 MICRO-INCHES OR STOCK FINISH ACCEPTABLE UNLESS OTHERWISE SPECIFIED.

NOTE: SUPPLY ALL SCREWS, NUTS, BOLTS, RIVETS, WASHERS, DOWELS, TAPER PINS, COTTER PINS & WOODRUFF KEYS WITH PART

MATERIAL 1.000 X .875 X .500 OFHC COPPER TUBING

PATTERN NO.	SCALE	USED ON
C 600T		

RCA Electronic Components EQUIPMENT DEVELOPMENT

DWG. TITLE ANODE STRAIN ISOLATION SLEEVE

DESIGN BY

MODEL NO.

DRAWN BY W. T. BURKINS

SIZE A DWG. NO. 302 5248R5

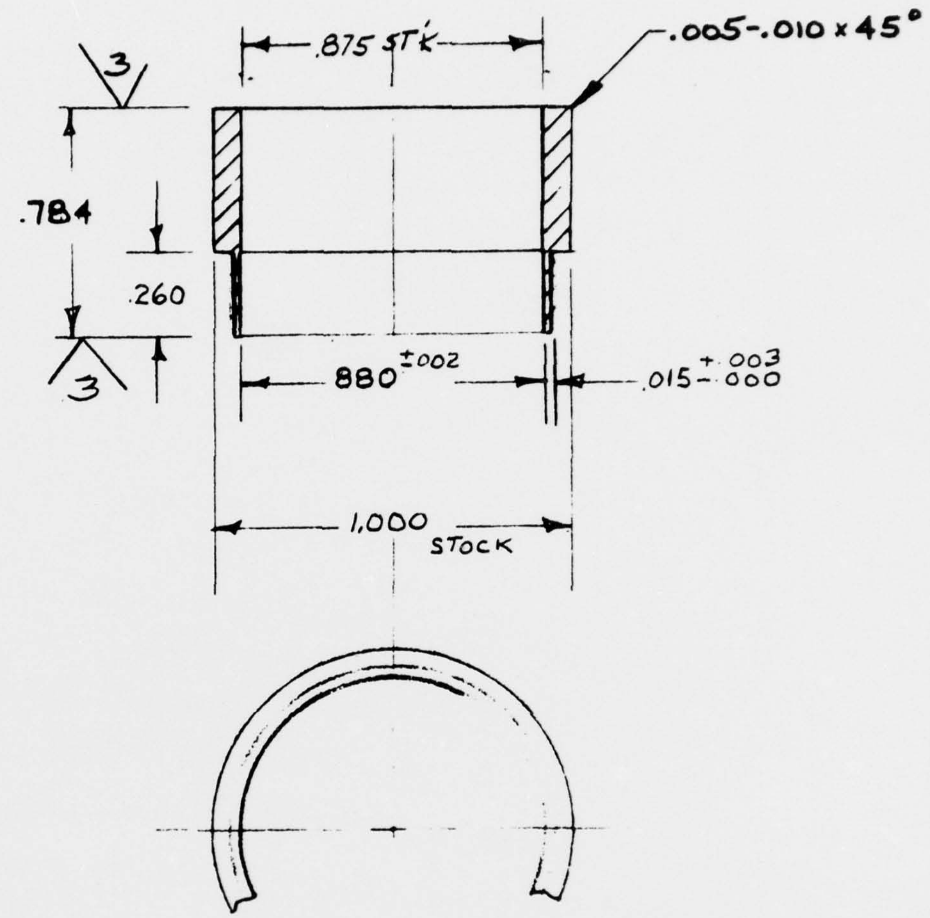
T659 8/69

DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING. DO NOT SCALE DRAWING. ALL EXTERNAL THREADS TO BE CLASS 2A BEFORE PLATING AND NOT GREATER THAN THE MAXIMUM SIZE OF CLASS 3A AFTER PLATING. ALL INTERNAL THREADS TO BE CLASS 2B UNLESS OTHERWISE SPECIFIED. ALL THREADS TO BE UNIFIED STANDARD SCREW THREAD SERIES UNLESS OTHERWISE SPECIFIED.

3025249R4

REVISIONS

AP. BY / DATE	0
Changed .015 +.005 -.000 to .015 +.003 -.000 WJB 5-3-76	1
Changed .744 to .734 WJBurkins 7-12-76	2
ADDED .005-.010x45° R. Miles Sept. 17, 1976	3
ADDED NOTES 1 & 2 R. Miles Jan. 20, 1977	4
Changed .734 to .784 & 3. WJBurkins 2-23-77	5



NOTES:

1. CLEAN COPPER WITH CHEM POLISH 14, PRIOR TO ASS'Y, PER SCHED. CL-1
2. DEBURR BUT DO NOT BREAK CORNERS
3. ENDS PERPENDICULAR TO ℄
4. 32 MICRO INCH MACHINED SURFACE FINISH

1,000 x .875 x .875 C-600T
MAT: OFHC COPPER TUBING

THESE DRAWINGS AND SPECIFICATIONS ARE THE PROPERTY OF RCA CORPORATION AND SHALL NOT BE REPRODUCED, OR COPIED, OR USED AS THE BASIS FOR THE MANUFACTURE OR SALE OF APPARATUS OR DEVICES WITHOUT PERMISSION.

TOLERANCES AND WORKMANSHIP REQUIREMENTS NOT SPECIFIED ON THIS DRAWING SHALL CONFORM TO SPECIFICATION 93650.

BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP THRU 6		
6 THRU 24		
ABOVE 24		
ANGULAR DIMENSIONS		

RCA CORPORATION
CATHODE STRAIN ISOLATION SLEEVE

FIRST MADE FOR | USED ON

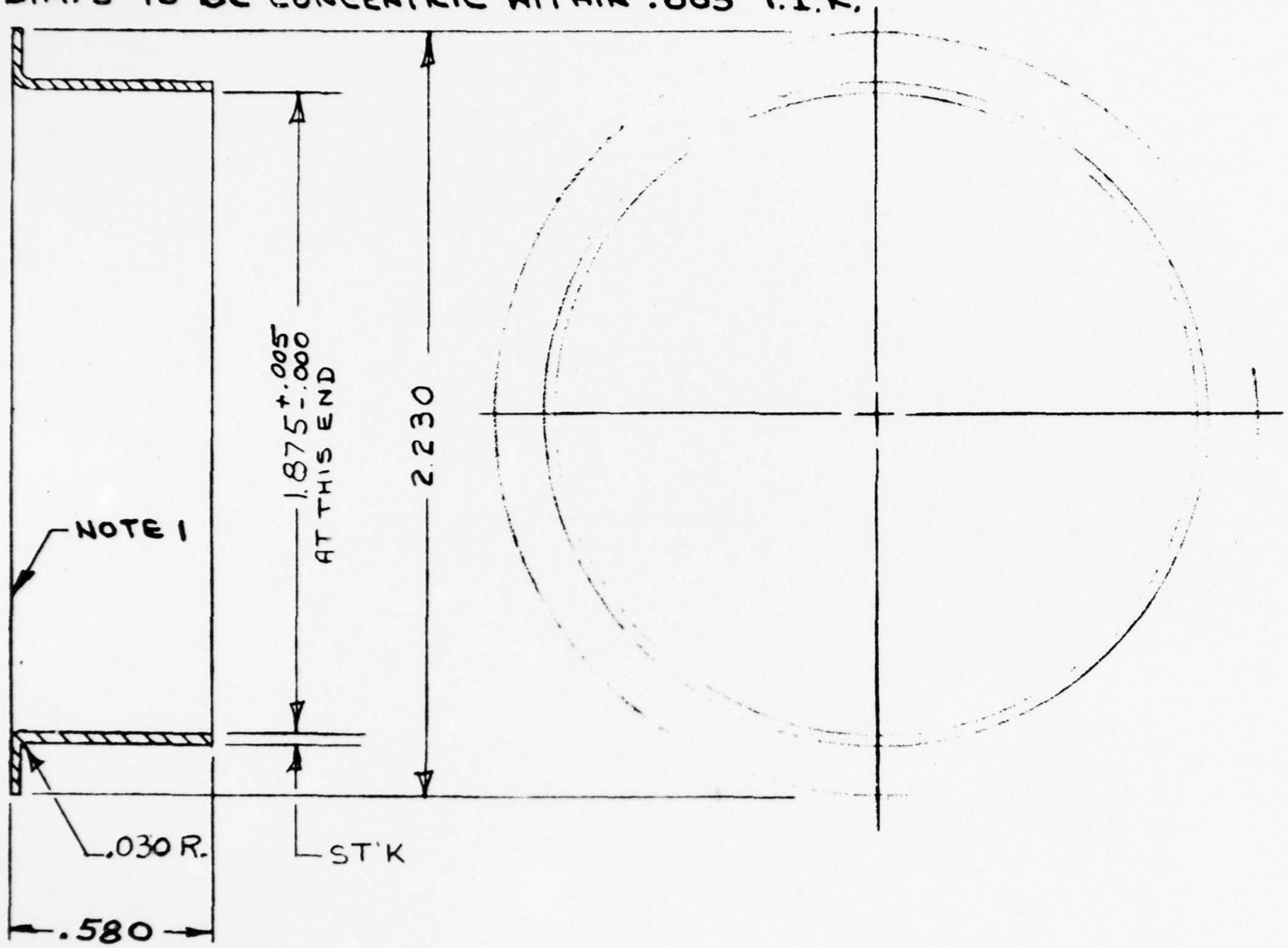
DRAWN BY W. T. BURKINS
DESIGNED BY
CHECKED BY
COMMODITY CODE

SIZE A | 302 5249R5

CODE IDENT NO. 49671 | SHEET | CONT'D ON SH

NOTES:

1. SURFACE TO BE FLAT WITHIN .002 T.I.R. & FREE OF TOOL MARKS
2. PARTS MUST BE FREE OF BURRS
3. DIA.'S TO BE CONCENTRIC WITHIN .005 T.I.R.



REVISIONS	
CHECKED BY	
APPROVED BY	0
.580 WAS .600 R. Miles Sept. 7, 1976	1
ADDED NOTES 1, 2 & 3 R. Miles Jan. 19, 1977	2

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STANDARD TOLERANCE		FRAC.	DEC.
BASIC DIM.		FRAC.	DEC.
UP TO 6"	±	1/64	.005
ABOVE 6"	±	1/32	.010
ABOVE 24"	±	1/16	.015
ANGULAR DIM. ± 1/2°			

NOTE: THREADS EXTERNAL, CLASS 2A; INTERNAL, CLASS 2B (AMERICAN STDS) UNLESS OTHERWISE SPECIFIED.

SURFACE ROUGHNESS OF 500 MICRO-INCHES OR STOCK FINISH ACCEPTABLE UNLESS OTHERWISE SPECIFIED.

NOTE: SUPPLY ALL SCREWS, NUTS, BOLTS, RIVETS, WASHERS, DOWELS, TAPER PINS, COTTER PINS & WOODRUFF KEYS WITH PART.

MATERIAL: C1010 - .030 TH'K C.R.S.

PATTERN NO. | SCALE | USED ON

RCA Electronic Components — EQUIPMENT DEVELOPMENT

DWG. TITLE: WELD RING

DESIGN BY: W J Buskins

DRAWN BY:

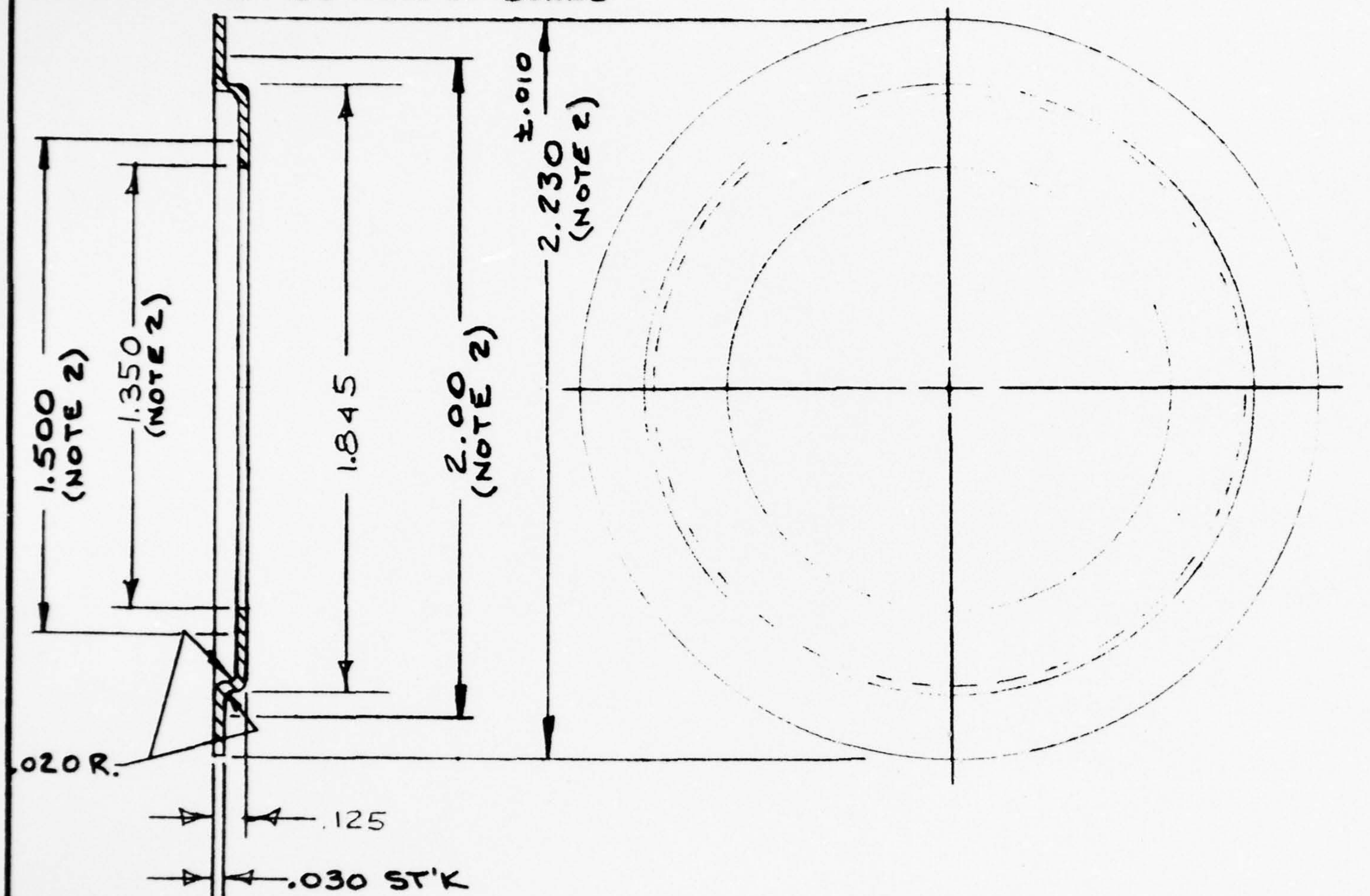
MODEL NO.: J1537IC

SIZE: A

DWG. NO.: 302-5258R2

T659 8/69

NOTES:
1. FIRE IN LINE HYDROGEN FOR 30 MIN. @ 900°C & @ 1100°C FOR 10-20 MIN. (AT RCA)
2. MUST BE FLAT WITHIN .002 BETWEEN THESE DIA.'S & FREE OF SCRATCHES & TOOL MARKS
3. DIA.'S TO BE CONCENTRIC WITHIN .005 T.I.R.
4. PART MUST BE FREE OF BURRS



REVISIONS	
CHECKED BY	
APPROVED BY	0
ADDED .020 RAD.; MAT'L WAS .020; ADDED FIRING NOTE; NOTE WAS: ALL BEND RADII EQUAL TO MAT'L TH'K — R. Miles Oct. 5, 1976	1
ADDED 1.500; 2.00; NOTES 2, 3, 4 — R. Miles Jan. 19, 1977	2

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STANDARD TOLERANCE			
BASIC DIM		FRAC.	DEC.
UP TO 6"	±	1/64	.005
ABOVE 6"	±	1/32	.010
ABOVE 24"	±	1/16	.015
ANGULAR DIM. ± 1/2°			

NOTE: THREADS EXTERNAL, CLASS 2A; INTERNAL, CLASS 2B (AMERICAN STDS) UNLESS OTHERWISE SPECIFIED.

SURFACE ROUGHNESS OF 300 MICRO-INCHES OR STOCK FINISH ACCEPTABLE UNLESS OTHERWISE SPECIFIED.

NOTE: SUPPLY ALL SCREWS, NUTS, BOLTS, RIVETS, WASHERS, DOWELS, TAPER PINS, COTTER PINS & WOODRUFF KEYS WITH PART.

MATERIAL	KOVAR .030 TH'K
PATTERN NO.	
SCALE	
USED ON	
DWG. TITLE	CATHODE WELD FLANGE
DESIGN BY	
MODEL NO.	J15371C
DRAWN BY	W.J. Burkans
SIZE	A
DWG. NO.	302-5259R2

RCA Electronic Components EQUIPMENT DEVELOPMENT

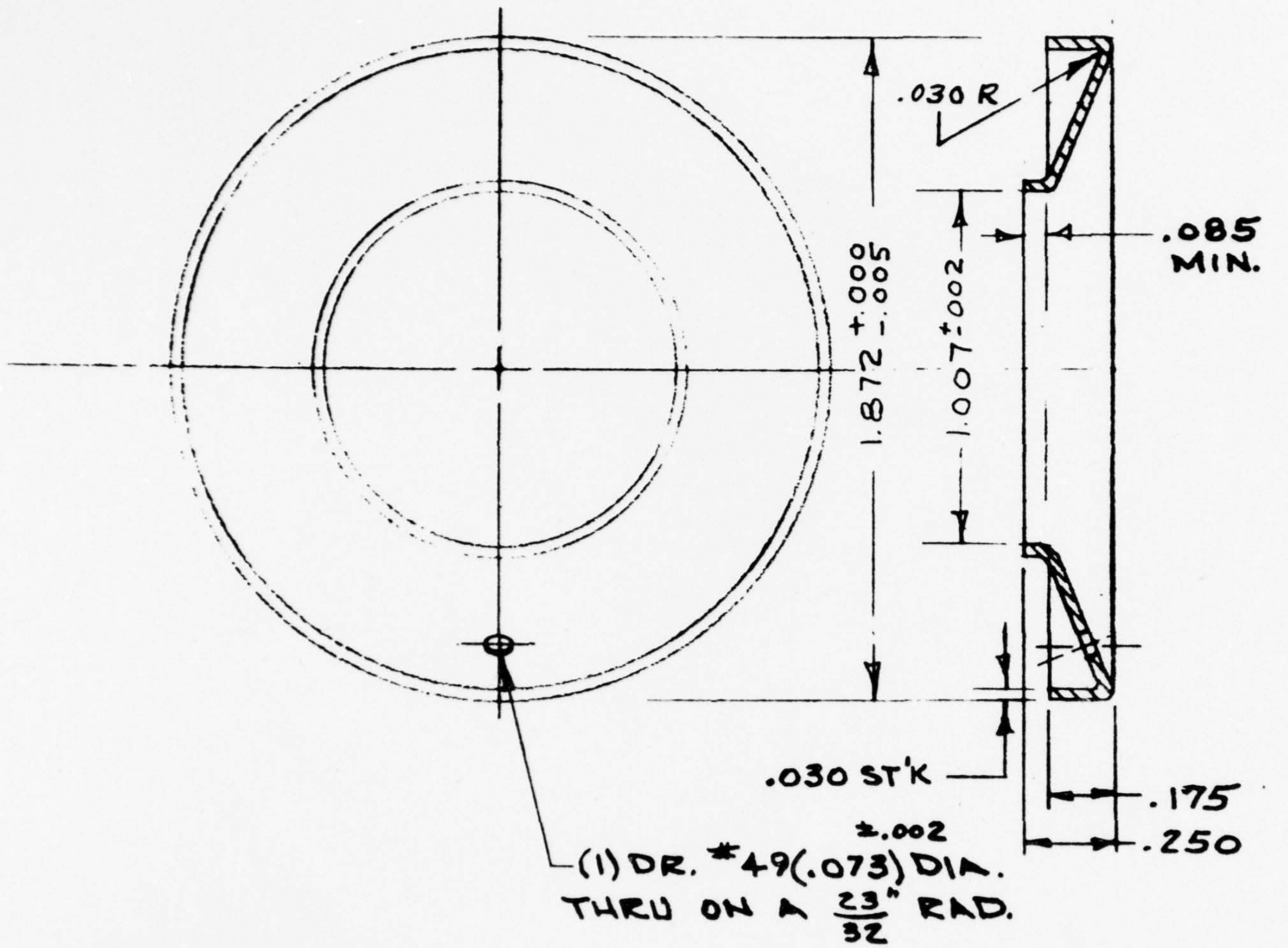
DRAWING 40-22 11830

TA59 8/69

NOTES:

1. NOT MORE THAN .002 TAPER PERMITTED ALONG O.D. OF PART
2. PARTS MUST BE FREE OF BURRS; TOOL MARKS, & SCRATCHES
3. .073 $^{\pm .002}$ DIA. HOLE MAY BE PUNCHED

REVISIONS	
CHECKED BY	
APPROVED BY	0
ADDED #49 HOLE R. Miles 8/8/76	1
#49 (.073) DIA. WAS ±.005; .085 MIN. WAS .050; ADDED NOTES 1, 2 & 3 R. Miles Jan. 19, 1977	2



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STANDARD TOLERANCE			
BASIC DIM.		FRAC.	DEC.
UP TO 6"	±	1/64	.005
ABOVE 6"	±	1/32	.010
ABOVE 24"	±	1/16	.015
ANGULAR DIM. ± 1/2°			

NOTE: THREADS EXTERNAL, CLASS 2A; INTERNAL, CLASS 2B (AMERICAN STDS) UNLESS OTHERWISE SPECIFIED.

SURFACE ROUGHNESS OF 500 MICRO-INCHES OR STOCK FINISH ACCEPTABLE UNLESS OTHERWISE SPECIFIED

NOTE: SUPPLY ALL SCREWS, NUTS, BOLTS, RIVETS, WASHERS, DOWELS, TAPER PINS, COTTER PINS & WOODRUFF KEYS WITH PART

MATERIAL	C1010-CRS S-10E2
PATTERN NO.	
SCALE	2:1
USED ON	
DWG. TITLE	ANODE WELD FLANGE
DESIGN BY	
MODEL NO.	J15371C
DRAWN BY	W J Burkam
SIZE	A
DWG. NO.	302-5260R2

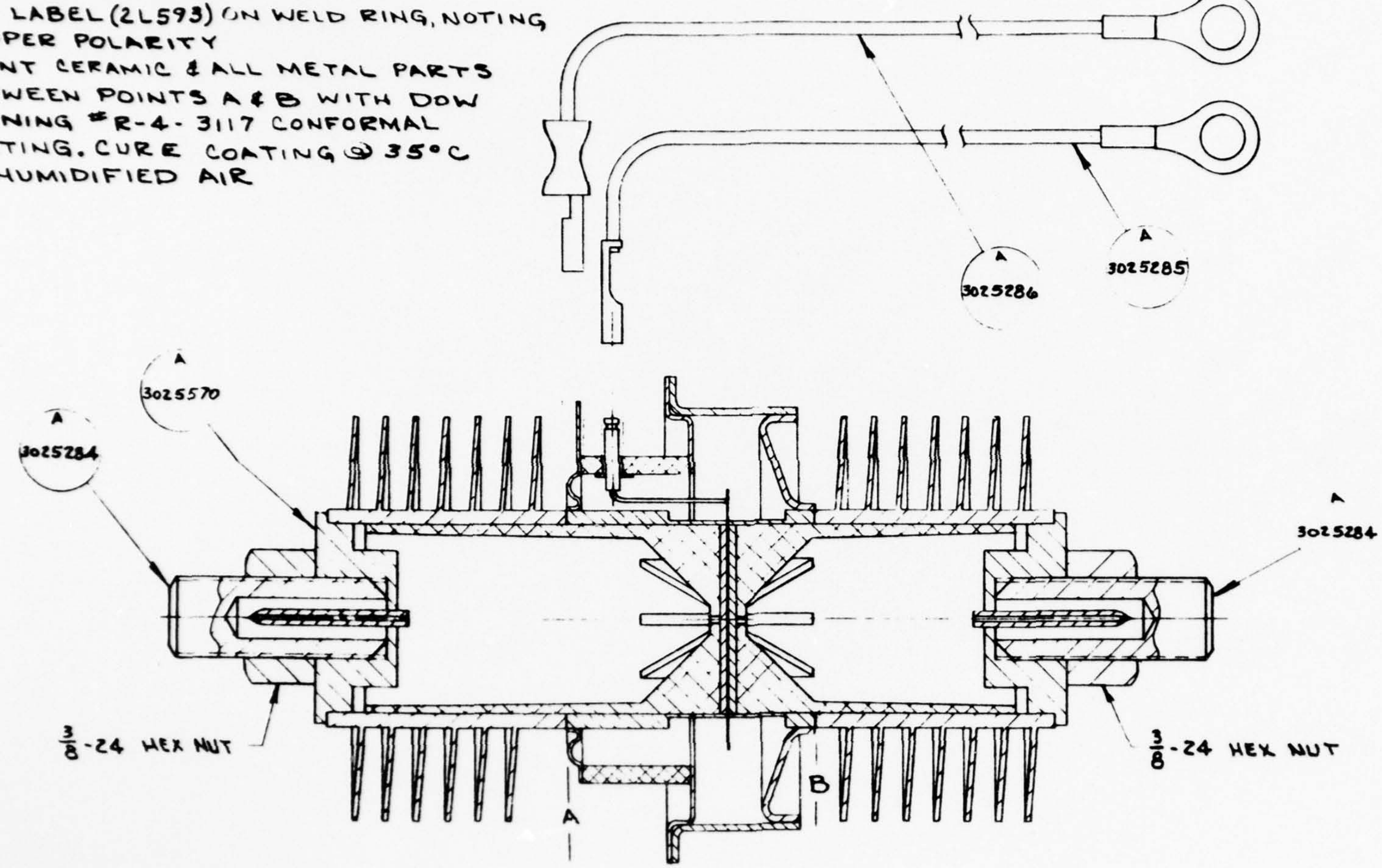
RCA Electronic Components EQUIPMENT DEVELOPMENT

BRUNING 40-22 11838

T659 8/69

FINISHING OPERATIONS:

1. PUT LABEL (2L593) ON WELD RING, NOTING PROPER POLARITY
2. PAINT CERAMIC & ALL METAL PARTS BETWEEN POINTS A & B WITH DOW CORNING #R-4-3117 CONFORMAL COATING. CURE COATING @ 35°C IN HUMIDIFIED AIR



REVISIONS	
CHECKED BY	
APPROVED BY	0
ADDED OPERATIONS R. Miles Jan. 21, 1977	1

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STANDARD TOLERANCE			
BASIC DIM.		FRAC	DEC.
UP TO 6"	±	1/64	.005
ABOVE 6"	±	1/32	.010
ABOVE 24"	±	1/16	.015
ANGULAR DIM.	±	1/2°	

NOTE: THREADS EXTERNAL, CLASS 2A; INTERNAL, CLASS 2B (AMERICAN STDS) UNLESS OTHERWISE SPECIFIED.

SURFACE ROUGHNESS OF 500 MICRO-INCHES OR STOCK FINISH ACCEPTABLE UNLESS OTHERWISE SPECIFIED.

NOTE: SUPPLY ALL SCREWS, NUTS, BOLTS, RIVETS, WASHERS, DOWELS, TAPER PINS, COTTER PINS & WOODRUFF KEYS WITH PART.

MATERIAL: CH

PATTERN NO. | SCALE 2:1 | USED ON

RADIO CORPORATION OF AMERICA
EQUIPMENT DEVELOPMENT

DWG. TITLE: TRANSCALENT THYRISTOR ASSY

DESIGN BY

MODEL NO. J15371C

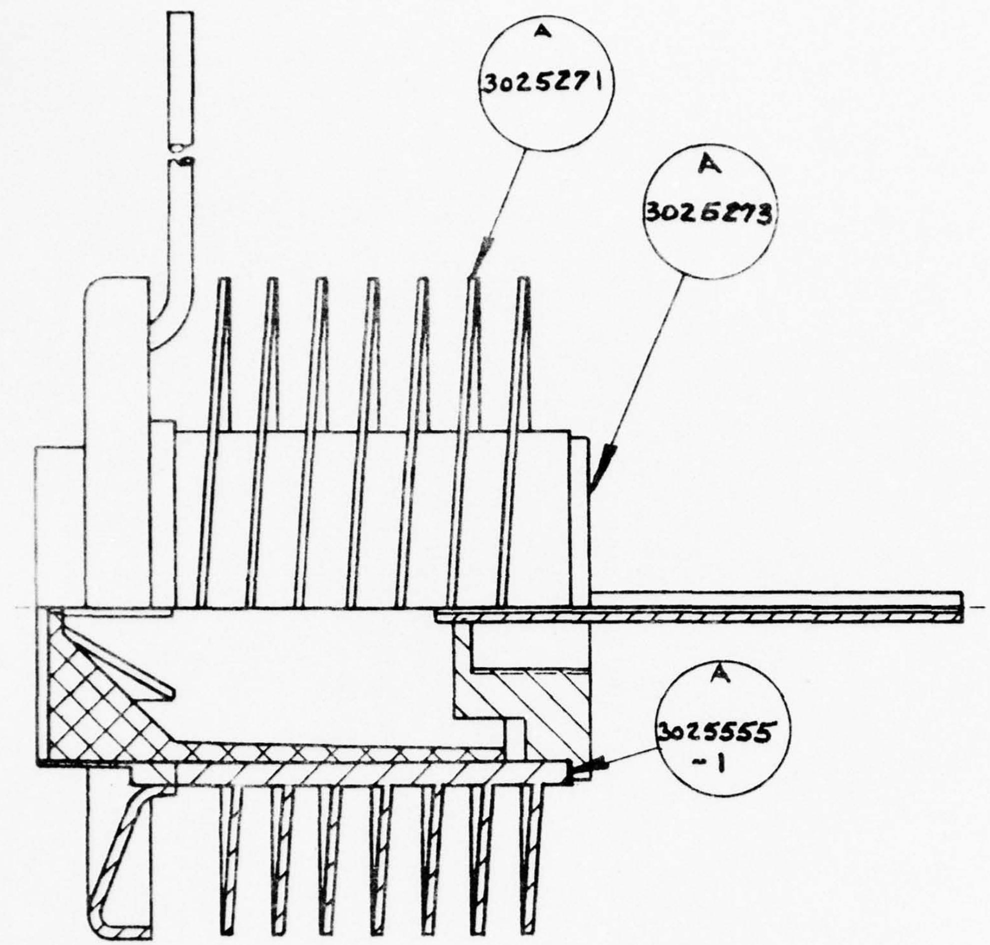
DRAWN BY: R. Miles Aug. 12, 1976

SIZE B | DWG. NO. 3025268R1

F 660 12/64

DEFIANCE NO 1060F-8 410

REVISIONS	
CHECKED BY	
APPROVED BY	0
ADDED FIRING SCHED. TO NOTE 4 R. Miles Jan. 20, 1977	1



SHEET 1 OF 2

THESE DRAWINGS AND SPECIFICATIONS ARE THE PROPERTY OF RCA CORPORATION AND ARE NOT TO BE REPRODUCED OR COPIED OR USED AS THE BASIS FOR THE MANUFACTURE OR SALE OF APPARATUS AND OR DEVICES WITHOUT PERMISSION

STANDARD TOLERANCE			
BASIC DIM		FRAC.	DEC.
UP TO 6"	±	1/64	.005
ABOVE 6"	±	1/32	.010
ABOVE 24"	±	1/16	.015
ANGULAR DIM. ± 1/2°			

NOTE: THREADS EXTERNAL, CLASS 2A, INTERNAL, CLASS 2B (AMERICAN STDS) UNLESS OTHERWISE SPECIFIED.

SURFACE ROUGHNESS OF 500 MICRO-INCHES OR STOCK FINISH ACCEPTABLE UNLESS OTHERWISE SPECIFIED

NOTE: SUPPLY ALL SCREWS, NUTS, BOLTS, RIVETS, WASHERS, DOWELS, TAPER PINS, COTTER PINS & WOODRUFF KEYS WITH PART

MATERIAL: H

PATTERN NO.: | SCALE: 2:1 | USED ON:

RCA Electronic Components ~~EQUIPMENT DEVELOPMENT~~

DWG. TITLE: ANODE HEAT PIPE ASS'Y

DESIGN BY:

MODEL NO.: J15371C

DRAWN BY: R. Miles Aug. 26, 1976

SIZE: A | DWG. NO.: 3025269R1

BRUNING 40-22 11838

T659 8/69

REVISIONS	
CHECKED BY	
APPROVED BY	0

NOTES:

1. BRAZE IN LINE HYDROGEN-PREHEAT IN VESTIBULE OF FURNACE FOR 15 MIN.; BRAZE @ 760°C FOR 20 MIN.; USE FIXT. NO. A3025583 FOR BRAZING
2. HELIUM LEAK CHECK; BACK FILL WITH NITROGEN & PINCH-OFF LONG
3. HAND LAP MOLY DISC END OF HEAT PIPE FLAT USING ALUM. OXIDE CARBORUNDUM 220 GRIT & 50% BENDIX 25 I CLEANER CONCENTRATE & 50% WATER AS A VEHICLE
4. ULTRASONIC WASH & RINSE & THEN FIRE @ 600°C FOR 10 MIN. IN LINE HYDROGEN JUST PRIOR TO NICKEL PLATING ENTIRE ASS'Y USING SCHED. N-2 FOR 12 MIN. @ 2 AMPS. USE MULTIPLE CLIPS TO GATE TERMINAL & TO WELD FLANGE. MOVE CLIPS TO NEW SITES @ 1/2 THE PLATING TIME
5. PLATE CHECK FOR BLISTERS IN HYDROGEN @ 600°C FOR 10 MIN.

SHEET 2 OF 2

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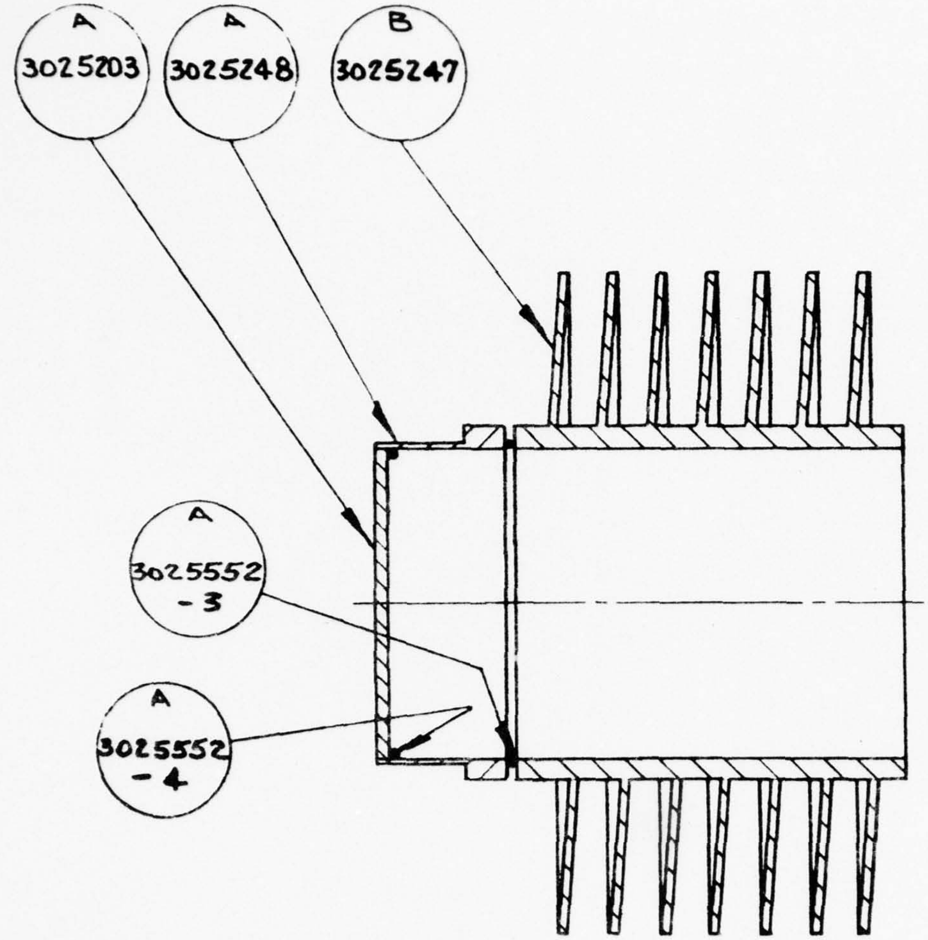
STANDARD TOLERANCE		FRAC.	DEC.				
BASIC DIM.				NOTE: THREADS EXTERNAL, CLASS 2A; INTERNAL, CLASS 2B (AMERICAN STDS) UNLESS OTHERWISE SPECIFIED.	MATERIAL CH		DWG. TITLE ANODE HEAT PIPE ASS'Y
UP TO 6"	±	1/64	.005	SURFACE ROUGHNESS OF 500 MICRO-INCHES OR STOCK FINISH ACCEPTABLE UNLESS OTHERWISE SPECIFIED	PATTERN NO.	SCALE CH	USED ON	DESIGN BY	MODEL NO. J15371C
ABOVE 6"	±	1/32	.010				
ABOVE 24"	±	1/16	.015	NOTE: SUPPLY ALL SCREWS, NUTS, BOLTS, RIVETS, WASHERS, DOWELS, TAPER PINS, COTTER PINS & WOODRUFF KEYS WITH PART.	RCA Electronic Components ~~EQUIPMENT DEVELOPMENT~~	DRAWN BY R. Miles Oct. 5, 1976	SIZE A DWG. NO. 3025269R1
ANGULAR DIM. ± 1/2°							

BRUNING 40-22 11838



REVISIONS	
CHECKED BY	
APPROVED BY	0
CHANGED LOC. OF PT. #A3025552-3; ADDED "AND CLEAN COP. PT.'S PER SCHED. CL-1" TO NOTE 2 R. Miles Jan. 20, 1977	1

NOTES:

1. BRAZE @ 1020°C FOR 15 MIN. IN LINE HYDROGEN. USE FIXT. #B3025254
2. VAPOR DEGREASE ALL PARTS BEFORE BRAZING & CLEAN COPPER PARTS PER SCHED. CL-1

THESE DRAWINGS AND SPECIFICATIONS ARE THE PROPERTY OF RCA CORPORATION AND ARE NOT TO BE REPRODUCED OR COPIED OR USED AS THE BASIS FOR THE MANUFACTURE OR SALE OF APPARATUS AND OR DEVICES WITHOUT PERMISSION

STANDARD TOLERANCE			
BASIC DIM		FRAC.	DEC.
UP TO 6"	±	1/64	.005
ABOVE 6"	±	1/32	.010
ABOVE 24"	±	1/16	.010
ANGULAR DIM ± 1/2°			

NOTE: THREADS EXTERNAL, CLASS 2A; INTERNAL, CLASS 2B (AMERICAN STDS) UNLESS OTHERWISE SPECIFIED.

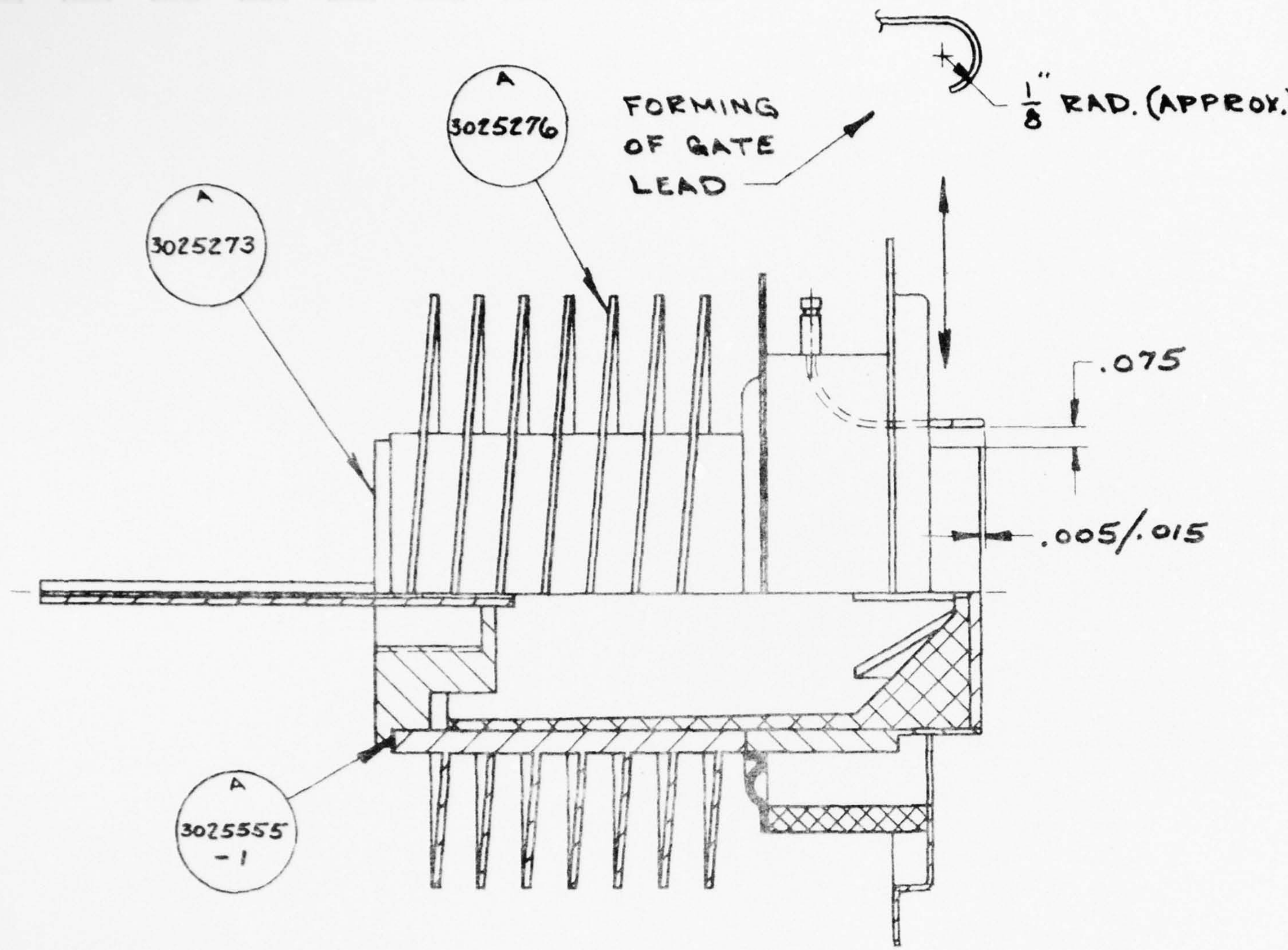
SURFACE ROUGHNESS OF 500 MICRO-INCHES OR STOCK FINISH ACCEPTABLE UNLESS OTHERWISE SPECIFIED.

NOTE: SUPPLY ALL SCREWS, NUTS, BOLTS, RIVETS, WASHERS, DOWELS, TAPER PINS, COTTER PINS & WOODRUFF KEYS WITH PART

MATERIAL: CH		DWG. TITLE: ANODE BODY SUB-ASS'Y
PATTERN NO.	SCALE: 2:1	USED ON
DESIGN BY		MODEL NO. J15371C
RCA Electronic Components ~~EQUIPMENT DEVELOPMENT~~	DRAWN BY: R. Miles Aug. 13, 1976	SIZE: A DWG. NO. 3025272R1

BRUNING 40-22 11838

T659 8/69



SHEET 1 OF 2

REVISIONS	
CHECKED BY	
APPROVED BY	0
ADDED NOTE 4 & MOVED OTHER NOTES; ADDED FIRING SCHED. TO NOTE 5 R. Miles Jan. 20, 1977	1

THESE DRAWINGS AND SPECIFICATIONS ARE THE PROPERTY OF RCA CORPORATION AND ARE NOT TO BE REPRODUCED OR COPIED OR USED AS THE BASIS FOR THE MANUFACTURE OR SALE OF APPARATUS AND OR DEVICES WITHOUT PERMISSION

STANDARD TOLERANCE			
BASIC DIM		FRAC.	DEC.
UP TO 6"	±	1/64	.005
ABOVE 6"	±	1/32	.010
ABOVE 24"	±	1/16	.015
ANGULAR DIM ± 1/2°			

NOTE: THREADS EXTERNAL, CLASS 2A; INTERNAL, CLASS 2B (AMERICAN STDS) UNLESS OTHERWISE SPECIFIED.

SURFACE ROUGHNESS OF 500 MICRO INCHES OR STOCK FINISH ACCEPTABLE UNLESS OTHERWISE SPECIFIED.

NOTE: SUPPLY ALL SCREWS, NUTS, BOLTS, RIVETS, WASHERS, DOWELS, TAPER PINS, COTTER PINS & WOODRUFF KEYS WITH PART

MATERIAL: H

PATTERN NO. | SCALE 2:1 | USED ON

RCA Electronic Components ~~EQUIPMENT DEVELOPMENT~~

DWG. TITLE: CATHODE HEAT PIPE ASS'Y

DESIGN BY

MODEL NO. J15371C

DRAWN BY: R. Miles Aug. 27, 1976

SIZE: A

DWG. NO. 3025274R1

BRUNING 40-22 11838

T659 8/69

REVISIONS

CHECKED BY

APPROVED BY 0

NOTES CONT.

1. BRAZE IN LINE HYDROGEN - PREHEAT IN VESTIBULE OF FURNACE FOR 15 MIN.; BRAZE @ 760°C FOR 20 MIN.; USE FIXT. NO. A3025583 FOR BRAZING
2. HELIUM LEAK CHECK; BACK FILL WITH NITROGEN & PINCH-OFF LONG
3. HAND LAP MOLY DISC END OF HEAT PIPE FLAT USING ALUM. OXIDE CARBORUNDUM 220 GRIT & 50% BENDIX 25 I CLEANER CONCENTRATE & 50% WATER AS A VEHICLE
4. USE A HYPODERMIC SYRINGE TO INJECT B-10 BINDER BETWEEN THE GATE LEAD & CERAMIC TO PREVENT PLATING SOLUTION FROM ENTERING THIS CAVITY
5. ULTRASONIC WASH & RINSE & THEN FIRE @ 600°C FOR 10 MIN. IN LINE HYDROGEN JUST PRIOR TO NICKEL PLATING ENTIRE ASS'Y USING SCHED. N-2 FOR 12 MIN. @ 2 AMPS. USE MULTIPLE CLIPS TO GATE TERMINAL & TO WELD FLANGE. MOVE CLIPS TO NEW SITES @ 1/2 THE PLATING TIME
6. PLATE CHECK FOR BLISTERS IN HYDROGEN @ 600°C FOR 10 MIN.
7. HAND FORM GATE LEAD AS SHOWN

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STANDARD TOLERANCE			
BASIC DIM.		FRAC.	DEC.
UP TO 6"	±	1/64	.005
ABOVE 6"	±	1/32	.010
ABOVE 24"	±	1/16	.015
ANGULAR DIM. ± 1/2°			

NOTE: THREADS EXTERNAL, CLASS 2A; INTERNAL, CLASS 2B (AMERICAN STDS) UNLESS OTHERWISE SPECIFIED.

SURFACE ROUGHNESS OF 500 MICRO-INCHES OR STOCK FINISH ACCEPTABLE UNLESS OTHERWISE SPECIFIED.

NOTE: SUPPLY ALL SCREWS, NUTS, BOLTS, RIVETS, WASHERS, DOWELS, TAPER PINS, COTTER PINS & WOODRUFF KEYS WITH PART.

MATERIAL: —

PATTERN NO. | SCALE: — | USED ON

RCA Electronic Components ~~EQUIPMENT DEVELOPMENT~~

DWG. TITLE: CATHODE HEAT PIPE ASS'Y

DESIGN BY

MODEL NO. J1537/C

DRAWN BY: R. Miles Oct. 5, 1976

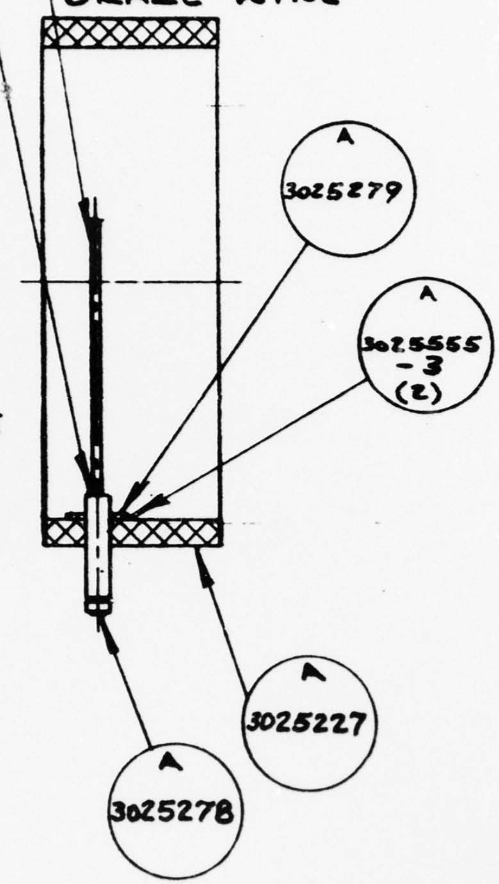
SIZE: A | DWG. NO. 3025274 R1

BRUNING 40-22 11838

T659 8/69

(1) SOL WIRE S35W(.020 DIA.) x 5/8" LG. INSERTED ALONG WITH NICKEL WIRE. EXTRA LENGTH WRAPPED AROUND NICKEL WIRE

(1) .030 DIA. NICKEL WIRE x 1" LG. CRIMP END INSERTED INTO PIN TO ALLOW FOR .020 DIA. BRAZE WIRE



NOTES:
1. VAPOR DEGREASE ALL METAL PARTS BEFORE BRAZING
2. BRAZE @1020°C FOR 15 MIN. IN LINE HYDROGEN. USE FIXT. #B3025556
3. HELIUM LEAK CHECK
4. BEFORE INSERTING NICKEL WIRE AT A SHARP RIGHT ANGLE .20 FROM ONE END. INSERT SHORT END INTO A3025278

REVISIONS	
CHECKED BY	
APPROVED BY	0
GEN'L REVISION R. Miles Jan. 20, 1977	1

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STANDARD TOLERANCE			
BASIC DIM		FRAC.	DEC.
UP TO 6"	±	1/64	.005
ABOVE 6"	±	1/32	.010
ABOVE 24"	±	1/16	.015
ANGULAR DIM. ± 1/2°			

NOTE: THREADS EXTERNAL, CLASS 2A; INTERNAL, CLASS 2B (AMERICAN STDS) UNLESS OTHERWISE SPECIFIED.

SURFACE ROUGHNESS OF 500 MICRO-INCHES OR STOCK FINISH ACCEPTABLE UNLESS OTHERWISE SPECIFIED

NOTE: SUPPLY ALL SCREWS, NUTS, BOLTS, RIVETS, WASHERS, DOWELS, TAPER PINS, COTTER PINS & WOODRUFF KEYS WITH PART.

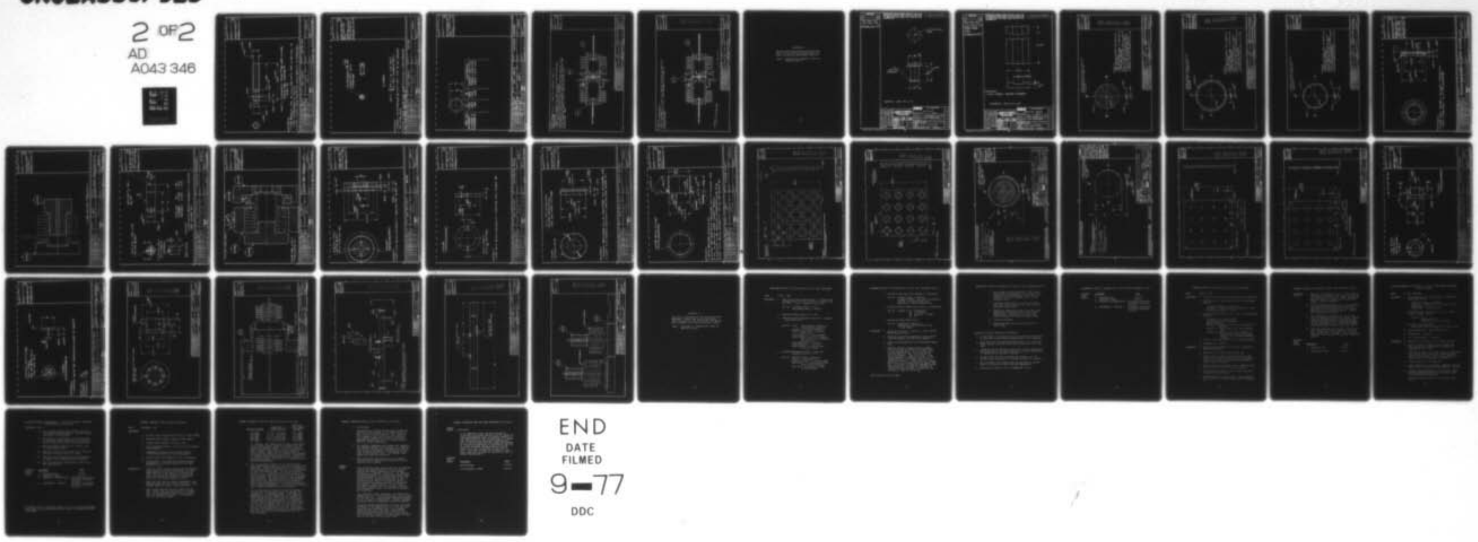
MATERIAL: AH			DWG. TITLE: CERAMIC INSULATOR ASS'Y
PATTERN NO.	SCALE 2:1	USED ON	DESIGN BY
MODEL NO. J15371C			
RCA Electronic Components ~~EQUIPMENT DEVELOPMENT~~			DRAWN BY R. Miles Aug. 27, 1976
SIZE A	DWG. NO. 3025277R1		

BRUNING 40-ZZ 11835

AD-A043 346   RCA CORP LANCASTER PA SSD-ELECTRO-OPTICS AND DEVICES   F/G 9/5
MANUFACTURING METHODS AND TECHNOLOGY (MM AND T), MEASURE FOR FA--ETC(U)
APR 77 S W KESSLER, R E REED, D R TROUT   DAAB07-76-C-8120

UNCLASSIFIED   NL

2 OF 2
AD
A043 346



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DATE
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9-77
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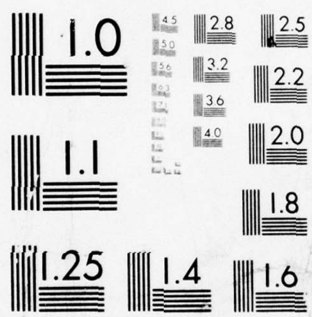
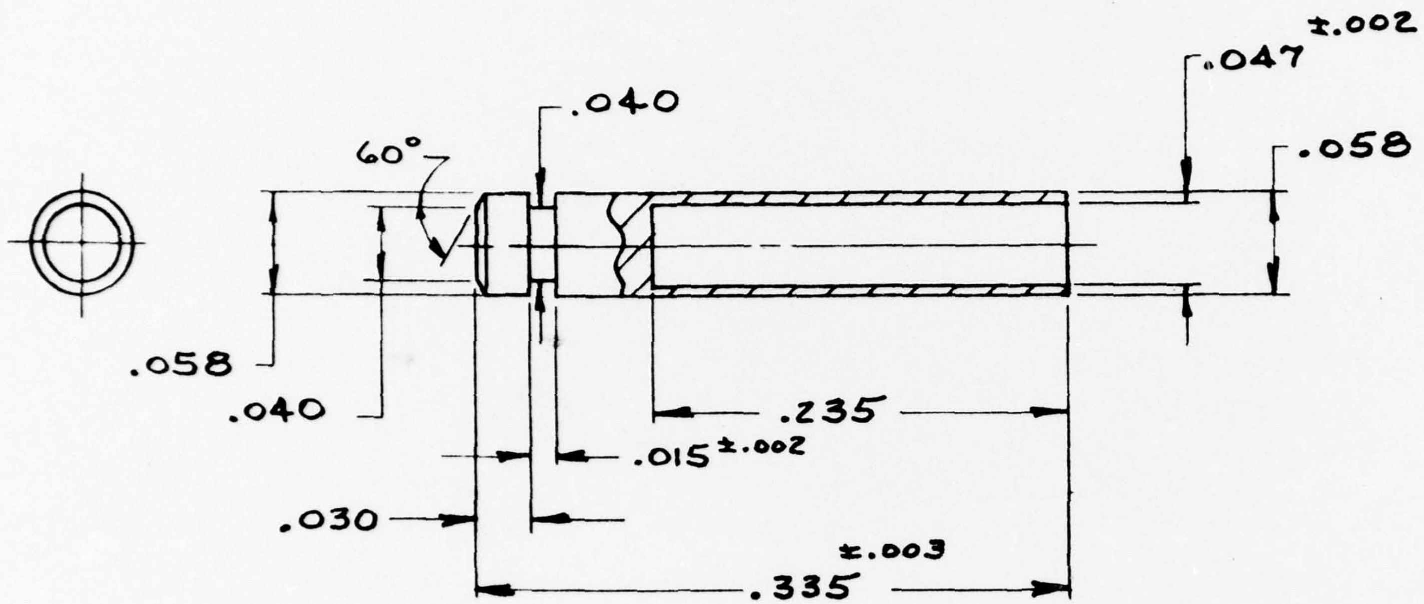


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A



MAT'L: TURNMATIC PART # 32.0531-KOVAR
(DIM.'S ARE VENDOR'S SPEC.'S)

NOTES:
1. FIRE @ 900°C FOR 30 MIN. & @ 1100°C FOR 10-20 MIN. IN LINE HYDROGEN (AT RCA)
2. NICKEL PLATE .0005 TH'K & PLATE CHECK @ 800°C IN HYDROGEN

REVISIONS	
CHECKED BY	
APPROVED BY	0
ADDED NOTE 2 R. Miles Jan. 20, 1977	1

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STANDARD TOLERANCE		FRAC.	DEC.
BASIC DIM			
UP TO 6"	±	1/64	.005
ABOVE 6"	±	1/32	.010
ABOVE 24"	±	1/16	.015
ANGULAR DIM ± 1/2°			

NOTE: THREADS EXTERNAL, CLASS 2A; INTERNAL, CLASS 2B (AMERICAN STDS) UNLESS OTHERWISE SPECIFIED.

SURFACE ROUGHNESS OF 500 MICRO-INCHES OR STOCK FINISH ACCEPTABLE UNLESS OTHERWISE SPECIFIED

NOTE: SUPPLY ALL SCREWS, NUTS, BOLTS, RIVETS, WASHERS, DOWELS, TAPER PINS, COTTER PINS & WOODRUFF KEYS WITH PART

MATERIAL: SEE ABOVE

DWG. TITLE: GATE PIN

PATTERN NO.: | SCALE: 10:1 | USED ON:

DESIGN BY:

MODEL NO.: J15371C

RCA Electronic Components ~~EQUIPMENT DEVELOPMENT~~

DRAWN BY: R. Miles Aug. 27, 1976

SIZE: A | DWG. NO.: 3025278R1

T659 8/69

BRUNING 40-22 11838

2-REQ'D

MAT'L: 3/8-24 x 1" LG. CUP POINT
SOC. SET SCREW (STL)

NOTES:

1. ANNEAL IN HYDROGEN @ 750°-775°C FOR 1/2 HR. BEFORE DRILLING HOLE
2. PLATE TYPE II CLEAR ZINC .0005 TH'K; FINISH-CLEAR CHROMATE (MIL STD QQZ-325, CLASS 2)

REVISIONS

CHECKED BY	
APPROVED BY	0
#3 DR. WAS 7/32"; MAT'L WAS FLAT POINT R. Miles Nov. 1, 1976	1
MAT'L WAS STN STL; ADDED NOTES 1 & 2 R. Miles Jan. 21, 1977	2

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STANDARD TOLERANCE		FRAC.	DEC.
BASIC DIM		FRAC.	DEC.
UP TO 6"	±	1/64	.005
ABOVE 6"	±	1/32	.010
ABOVE 24"	±	1/16	.015
ANGULAR DIM ± 1/2°			

NOTE: THREADS EXTERNAL, CLASS 2A; INTERNAL, CLASS 2B (AMERICAN STDS) UNLESS OTHERWISE SPECIFIED.
SURFACE ROUGHNESS OF 500 MICRO-INCHES OR STOCK FINISH ACCEPTABLE UNLESS OTHERWISE SPECIFIED.
NOTE: SUPPLY ALL SCREWS, NUTS, BOLTS, RIVETS, WASHERS, DOWELS, TAPER PINS, COTTER PINS & WOODRUFF KEYS WITH PART

MATERIAL: SEE ABOVE			DWG. TITLE: STUD
PATTERN NO.	SCALE: 1:1	USED ON	DESIGN BY
RCA Electronic Components ~~EQUIPMENT DEVELOPMENT~~			DRAWN BY: R. Miles Sept. 14, 1976

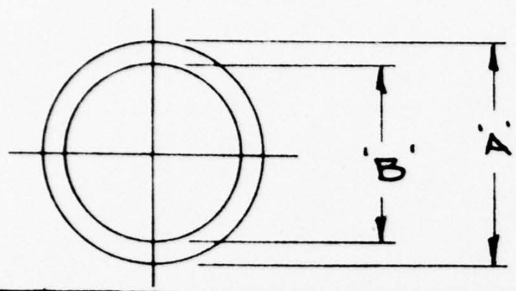
MODEL NO. J15371C

SIZE: A DWG. NO. 3025284R2

BRUNING 40-22 11838

T659 8/69

REVISIONS	
CHECKED BY	
APPROVED BY	0
PT. 3025555-3 WAS C68751x.004 TH'K R. Miles Jan. 20, 1977	1



PART NO.	'A'	'B'	MATERIAL
3025555-1	1.080	.880	S636S x.003 TH'K
3025555-2	1.500	1.315	S35S x.003 TH'K
3025555-3	.150	.063	S35S . x.010 TH'K

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STANDARD TOLERANCE			
BASIC DIM.		FRAC.	DEC.
UP TO 6"	±	1/64	.005
ABOVE 6"	±	1/32	.010
ABOVE 24"	±	1/16	.015
ANGULAR DIM. ± 1/2°			

NOTE: THREADS EXTERNAL, CLASS 2A; INTERNAL, CLASS 2B (AMERICAN STDS) UNLESS OTHERWISE SPECIFIED.

SURFACE ROUGHNESS OF 500 MICRO-INCHES OR STOCK FINISH ACCEPTABLE UNLESS OTHERWISE SPECIFIED.

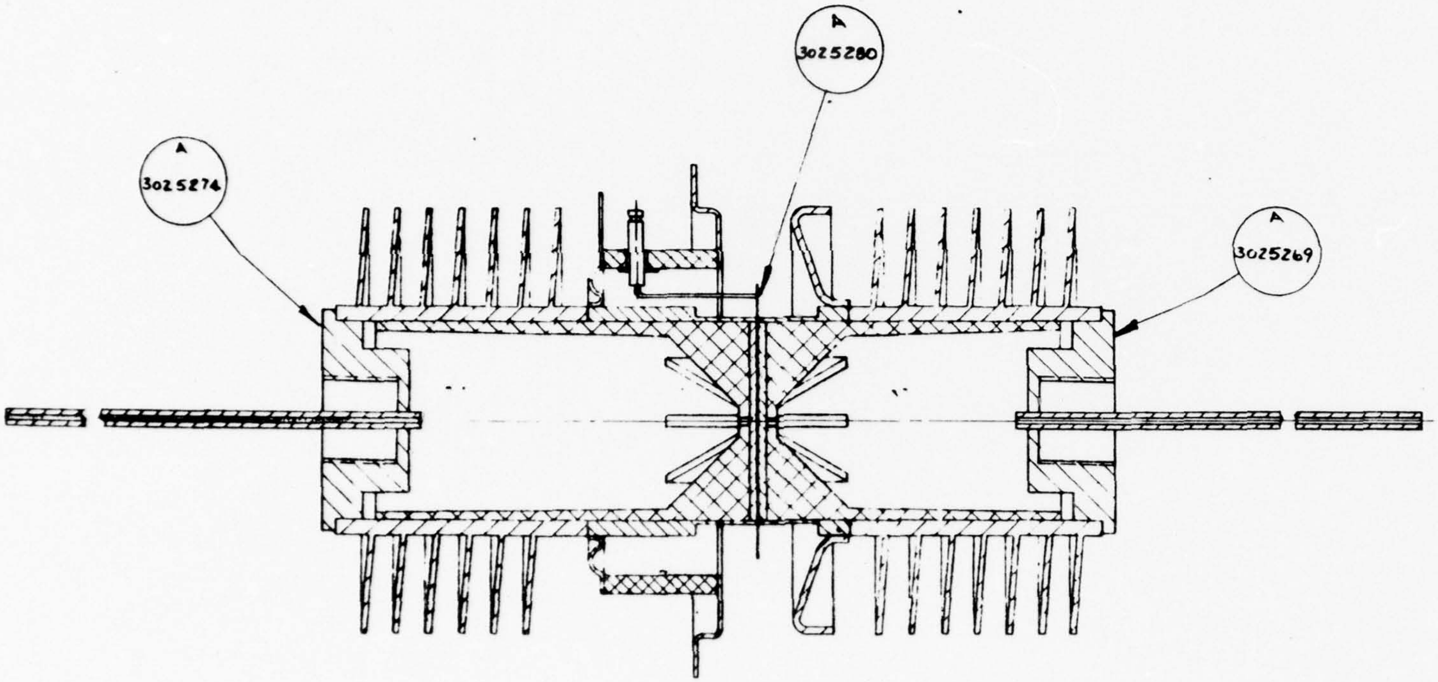
NOTE: SUPPLY ALL SCREWS, NUTS, BOLTS, RIVETS, WASHERS, DOWELS, TAPER PINS, COTTER PINS & WOODRUFF KEYS WITH PART.

MATERIAL: SEE ABOVE			DWG. TITLE: SOLDER WASHER
PATTERN NO.	SCALE: NONE	USED ON	DESIGN BY
MODEL NO. J15371C			
RCA Electronic Components ~~EQUIPMENT DEVELOPMENT~~			DRAWN BY: R. Miles Oct. 5, 1976
SIZE: A	DWG. NO. 3025555R1		

T650 8/60

NOTES:

1. BRAZE @ 395°C, 5 MIN., 3 TORR OF HYDROGEN. USE FIXT. #B3025289
2. INSPECT TO INSURE A SOLDER FILLET IS FORMED BETWEEN GATE LEAD & GATE RING ON A3025280
3. COAT EDGE OF SILICON WITH R-6104 FLEXIBLE JUNCTION COATING. MIX 10 PARTS BASE TO 1 PART CURING AGENT. DE-AIR MIXTURE IN VACUUM FOR 5 MIN. CURE FOR 2HRS. @150° IN CIRCULATING AIR OVEN
4. ELECTRICAL TEST



REVISIONS	
CHECKED BY	
APPROVED BY	0
ADDED NOTES 2, 3 & 4 R. Mikea Jan. 21, 1977	1

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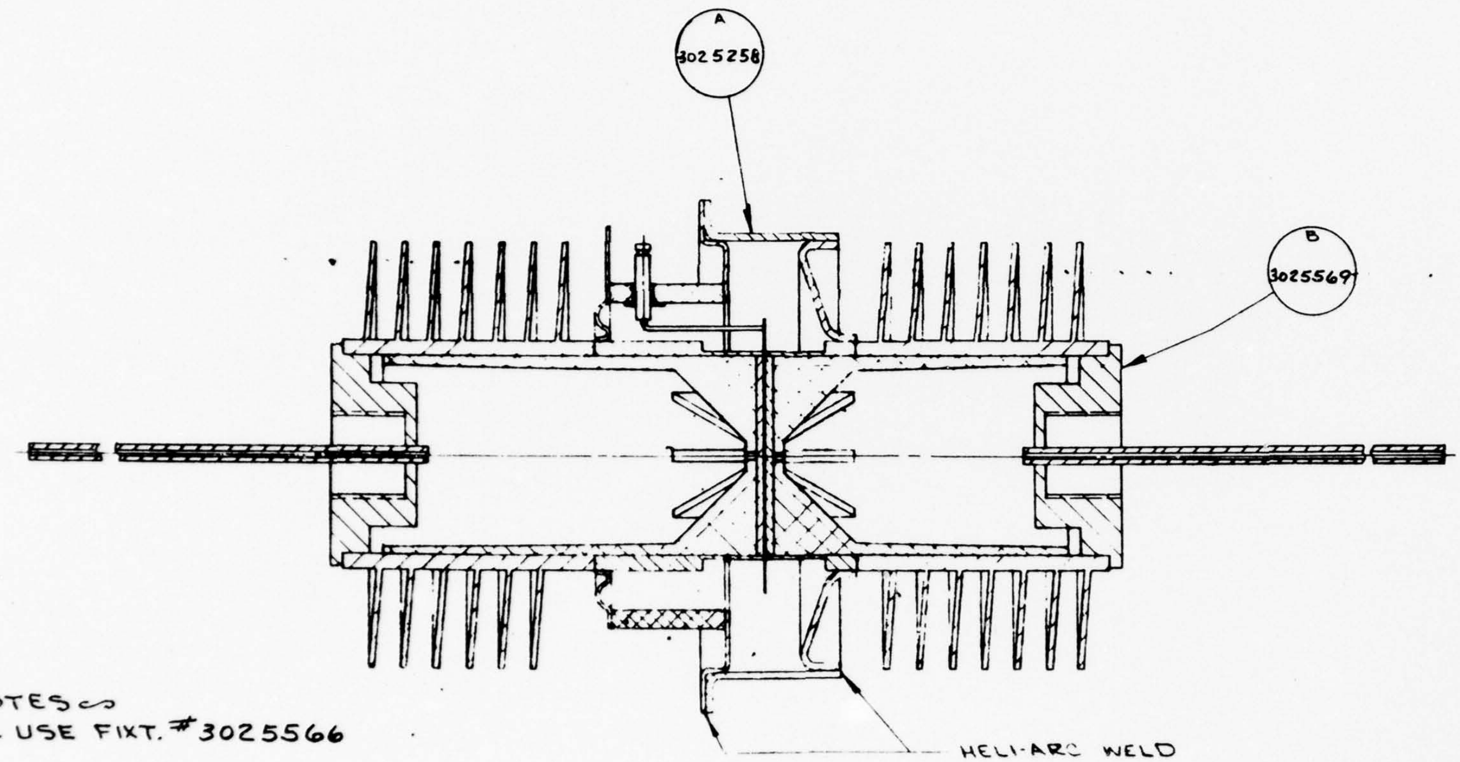
STANDARD TOLERANCE				NOTE	MATERIAL	DWG. TITLE
BASIC DIM		FRAC	DEC	THREADS EXTERNAL, CLASS 2A INTERNAL, CLASS 2B (AMERICAN STDS) UNLESS OTHERWISE SPECIFIED	CH	THYRISTOR ASS'Y, BRAZED
UP TO 6"	±	1/64	.005	SURFACE ROUGHNESS OF 500 MICRO-INCHES OR STOCK FINISH ACCEPTABLE UNLESS OTHERWISE SPECIFIED	PATTERN NO / SCALE 2:1 / USED ON	DESIGN BY / MODEL NO. J15371C
ABOVE 6"	±	1/32	.010			
ABOVE 24"	±	1/16	.015	NOTE SUPPLY ALL SCREWS, NUTS, BOLTS, RIVETS, WASHERS, DOWELS, TAPER PINS, COTTER PINS & WOODRUFF KEYS WITH PART	RADIO CORPORATION OF AMERICA EQUIPMENT DEVELOPMENT	DRAWN BY R. Mikea Oct. 25, 1976 / SIZE B / DWG NO 3025569R1
ANGULAR DIM	±	1/2°				

NOTES:
1. USE FIXT. #B3025566
2. APPLY CONFORMAL COATING TO CERAMIC AT BASE OF GATE PIN. CAPILLARY FORCE WILL FILL GAP BETWEEN PIN & CERAMIC
3. NICKEL PLATE

REVISIONS	
CHECKED BY	
APPROVED BY	0
ADDED NOTES 2 & 3	
R. Miles Jan. 24, 1977	1



NOTES:
1. USE FIXT. #3025566

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STANDARD TOLERANCE			
BASIC DIM		FRAC	DEC
UP TO 6"	±	1/64	.005
ABOVE 6"	±	1/32	.010
ABOVE 24"	±	1/16	.015
ANGULAR DIM.	± 1/2°		

NOTE: THREADS EXTERNAL, CLASS 2A; INTERNAL, CLASS 2B (AMERICAN STDS) UNLESS OTHERWISE SPECIFIED

SURFACE ROUGHNESS OF 500 MICRO-INCHES OR STOCK FINISH ACCEPTABLE UNLESS OTHERWISE SPECIFIED

NOTE: SUPPLY ALL SCREWS, NUTS, BOLTS, RIVETS, WASHERS, DOWELS, TAPER PINS, COTTER PINS & WOODRUFF KEYS WITH PART

MATERIAL: CH

PATTERN NO. | SCALE 2:1 | USED ON

RADIO CORPORATION OF AMERICA
EQUIPMENT DEVELOPMENT

DWG TITLE: THYRISTOR ASS'Y, WELDED

DESIGN BY

MODEL NO. J15371C

DRAWN BY: R. Miles Oct. 25, 1976

SIZE B | DWG NO. 3025570R1

T 690 12/66

APPENDIX B

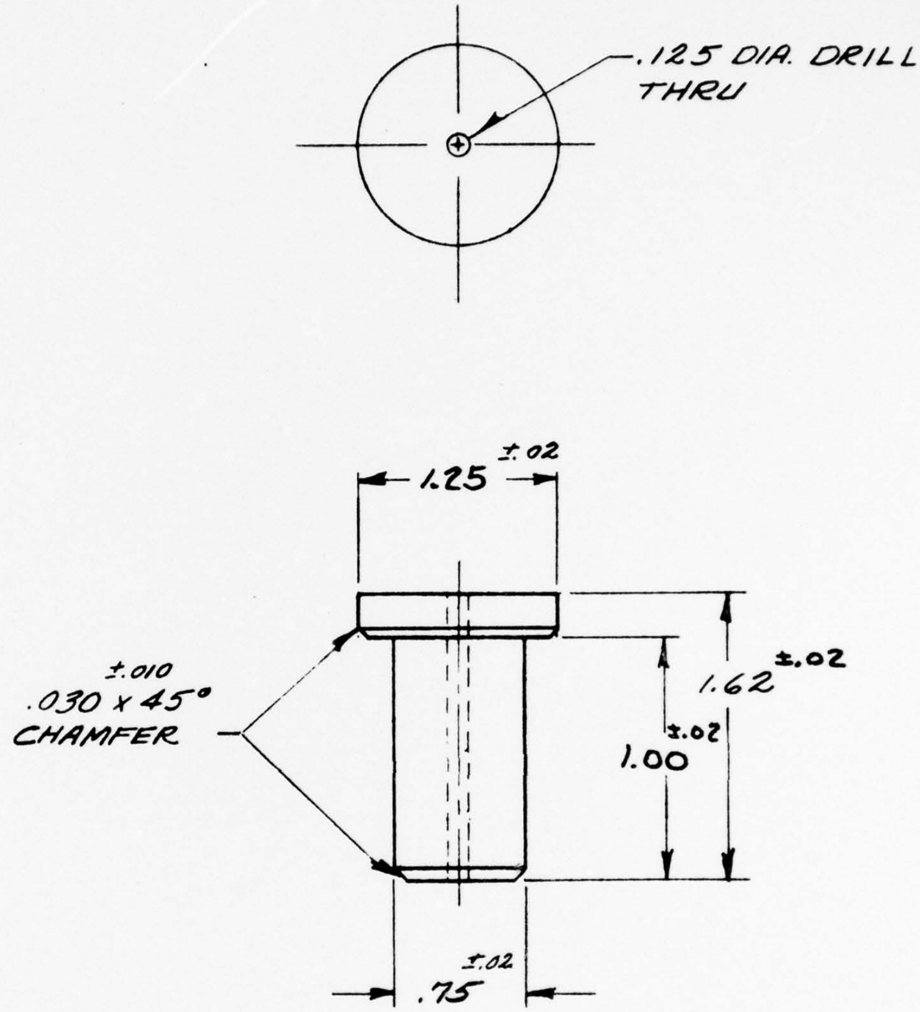
Revised Tooling and Photo-Mask Drawings. Refer to the First Quarterly Report for other tooling and photo-mask drawings.

(Note: Organized in numerical order by Drawing Number.)

REVISIONS	
AP. BY	0
DATE	
1.25 WAS 1.12; 1.00 WAS 1.375	
R. Miles Jan. 25, 1977	1

DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING. DO NOT SCALE DRAWING. ALL EXTERNAL THREADS TO BE CLASS 2A BEFORE PLATING AND NOT GREATER THAN THE MAXIMUM SIZE OF CLASS 3A AFTER PLATING. ALL INTERNAL THREADS TO BE CLASS 2B UNLESS OTHERWISE SPECIFIED. ALL THREADS TO BE UNIFIED STANDARD SCREW THREAD SERIES UNLESS OTHERWISE SPECIFIED.

3025231R1



MATERIAL - 304 STN. ST'L

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TOLERANCES AND WORKMANSHIP REQUIREMENTS NOT SPECIFIED ON THIS DRAWING SHALL CONFORM TO SPECIFICATION 93650.

BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP THRU 6		
6 THRU 24		
ABOVE 24		
ANGULAR DIMENSIONS		

RCA — RCA CORPORATION

WEIGHT

FIRST MADE FOR — USED ON

DRAWN BY R.G. HERR 2-7-75

DESIGNED BY S.W. KESSLER

CHECKED BY

COMMODITY CODE

A SIZE — 3025231R1

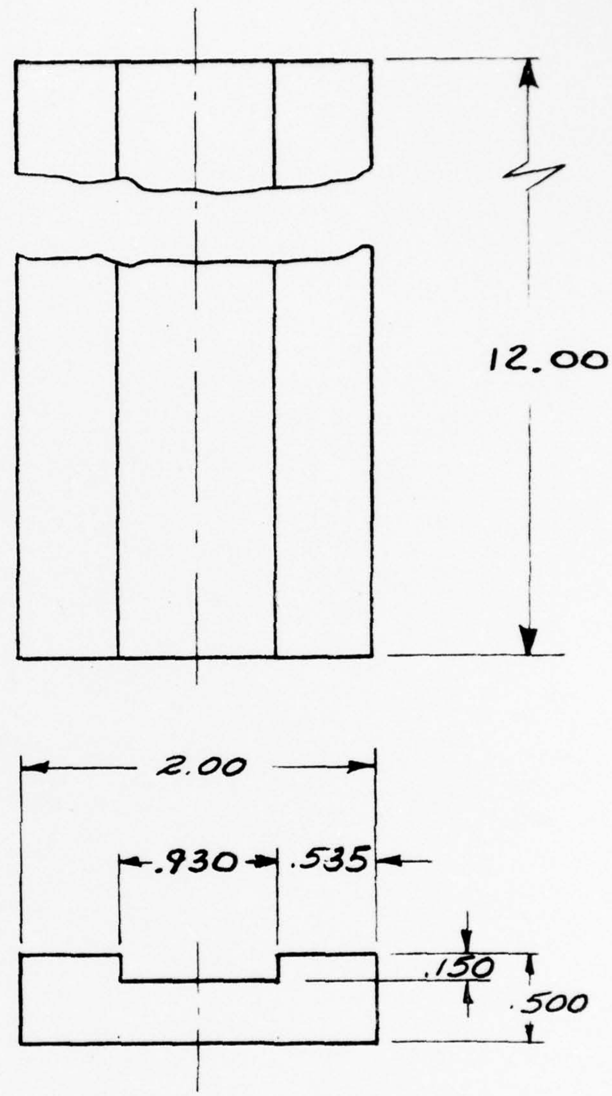
CODE IDENT NO. 49671 — SHEET — CONT'D ON SH

RCA 414-2 REV. 2 2-73 PRINTED IN U.S.A.

REVISIONS	
AP. BY	0
DATE	
.930 WAS .915; 12.00 WAS 10.00; ADDED NOTE 1; .535 WAS .542	
R. Miles Jan. 20, 1977	1

DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING. DO NOT SCALE DRAWING. ALL EXTERNAL THREADS TO BE CLASS 2A BEFORE PLATING AND NOT GREATER THAN THE MAXIMUM SIZE OF CLASS 3A AFTER PLATING. ALL INTERNAL THREADS TO BE CLASS 2B UNLESS OTHERWISE SPECIFIED. ALL THREADS TO BE UNIFIED STANDARD SCREW THREAD SERIES UNLESS OTHERWISE SPECIFIED.

3025232R1



NOTES:
1. SAW & BELT SAND EDGES

MATERIAL - 304 STN. STL

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TOLERANCES AND WORKMANSHIP REQUIREMENTS NOT SPECIFIED ON THIS DRAWING SHALL CONFORM TO SPECIFICATION 93650.

BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP THRU 6		
6 THRU 24		
ABOVE 24		
ANGULAR DIMENSIONS		

RCA — RCA CORPORATION

BRAZING BASE

FIRST MADE FOR — USED ON

DRAWN BY R.G. HERR 5-7-75

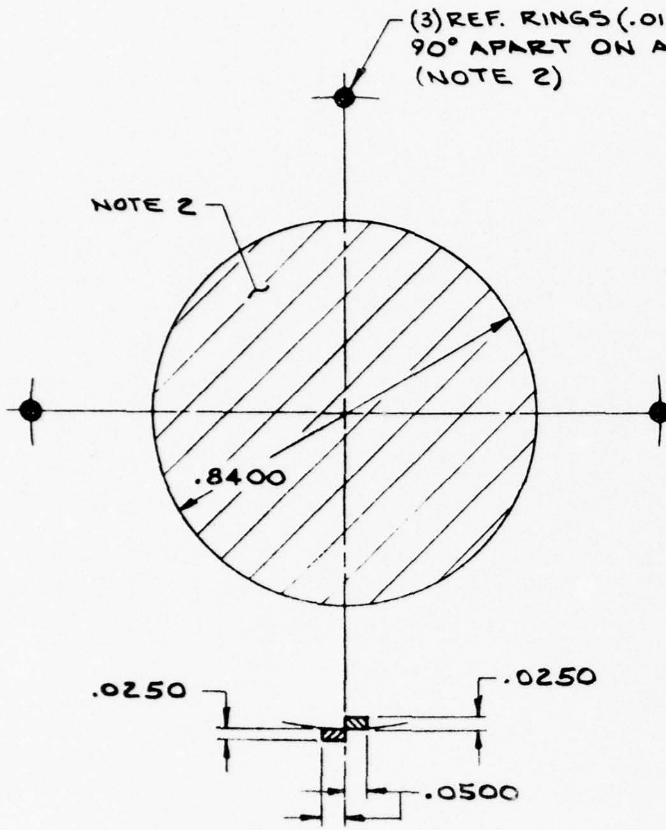
DESIGNED BY S.W. KESSLER

CHECKED BY

COMMODITY CODE

A SIZE — 3025232R1

CODE IDENT NO. 49671 | SHEET | CONT'D ON SH



NOTES:

1. SEE DWG. NO. 3025261 FOR SHORTING DOT PATTERN
2. CROSS-HATCHED AREA IS CHROME ON MASK (NEG. RESIST)
3. TOL. ON MASK ±.0002 FOR ALL DIM.'S
4. PRINT MASK ON 2" x 2" SLIDES
5. THIS MASK IS REFERRED TO AS MASK 'A' ON PROCESS SHEETS
6. CENTER MASK ON SLIDE WITHIN ± 1/16"

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REVISIONS	
CHECKED BY	
APPROVED BY	0
NOTE 4 WAS 2½ x 2½ SLIDES; ADDED NOTE 6 R. Miles Jan. 21, 1977	1

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STANDARD TOLERANCE			
BASIC DIM.		FRAC.	DEC.
UP TO 6"	±	1/64	.005
ABOVE 6"	±	1/32	.010
ABOVE 24"	±	1/16	.015
ANGULAR DIM.	±	1/2°	

NOTE: THREADS EXTERNAL, CLASS 2A; INTERNAL, CLASS 2B (AMERICAN STDS) UNLESS OTHERWISE SPECIFIED.

SURFACE ROUGHNESS OF 500 MICRO-INCHES OR STOCK FINISH ACCEPTABLE UNLESS OTHERWISE SPECIFIED.

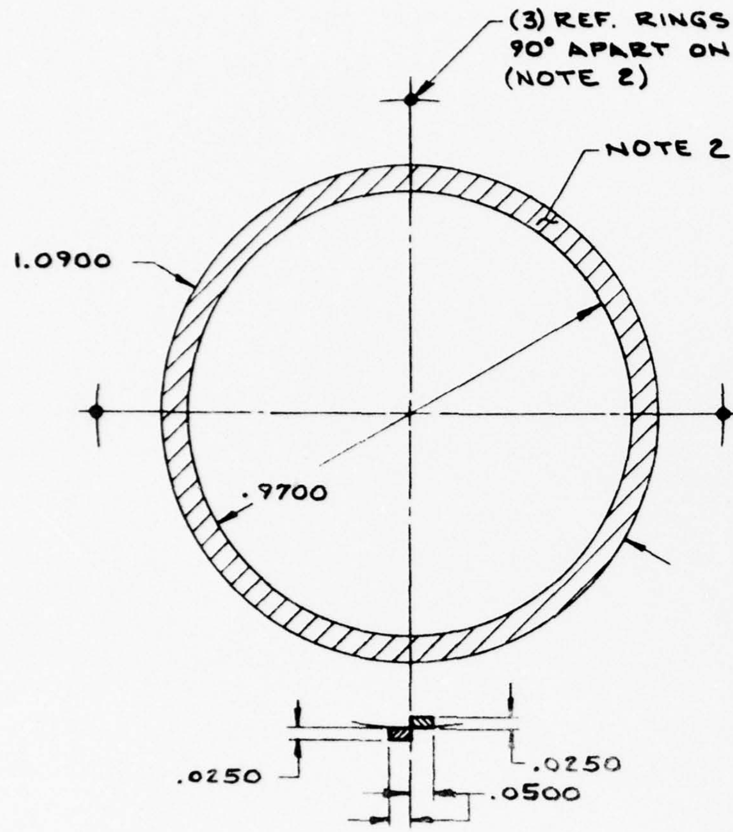
NOTE: SUPPLY ALL SCREWS, NUTS, BOLTS, RIVETS, WASHERS, DOWELS, TAPER PINS, COTTER PINS & WOODRUFF KEYS WITH PART.

MATERIAL	—
PATTERN NO.	
SCALE	4:1
USED ON	
DWG. TITLE	MASK FOR N^+ EMITTER DIFFUSION
DESIGN BY	
MODEL NO.	J15371C
DRAWN BY	R. Miles Dec. 6, 1976
SIZE	B
DWG. NO.	3025262R1

RADIO CORPORATION OF AMERICA
~~EQUIPMENT DEVELOPMENT~~

T 560 12/56

DEFIANCE NO. 10807-8 470



NOTES:

1. SEE DWG. NO. 3025261 FOR SHORTING DOT PATTERN
2. CROSS-HATCHED AREA IS CHROME ON MASK (NEG. RESIST)
3. TOL. ON MASK ±.0002 FOR ALL DIM'S.
4. PRINT MASK ON 2" X 2" SLIDES
5. THIS MASK IS REFERRED TO AS MASK 'B' ON PROCESS SHEETS
6. CENTER MASK ON SLIDE WITHIN ± 1/16"

REVISIONS

CHECKED BY

APPROVED BY — 0

REDRAWN; ADDED NOTE 5 — R. Miles Nov. 30, 1976 — 1

NOTE 4 WAS 2½ X 2½ SLIDES; ADDED NOTE 6 — R. Miles Jan. 21, 1977 — 2

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STANDARD TOLERANCE			
BASIC DIM.		FRAC.	DEC.
UP TO 6"	±	1/64	.005
ABOVE 6"	±	1/32	.010
ABOVE 24"	±	1/16	.015
ANGULAR DIM.	±	1/2°	

NOTE: THREADS EXTERNAL, CLASS 2A; INTERNAL, CLASS 2B (AMERICAN STDS) UNLESS OTHERWISE SPECIFIED.

SURFACE ROUGHNESS OF 500 MICRO-INCHES OR STOCK FINISH ACCEPTABLE UNLESS OTHERWISE SPECIFIED.

NOTE: SUPPLY ALL SCREWS, NUTS, BOLTS, RIVETS, WASHERS, DOWELS, TAPER PINS, COTTER PINS & WOODRUFF KEYS WITH PART.

MATERIAL:

PATTERN NO.: | SCALE: 4:1 | USED ON:

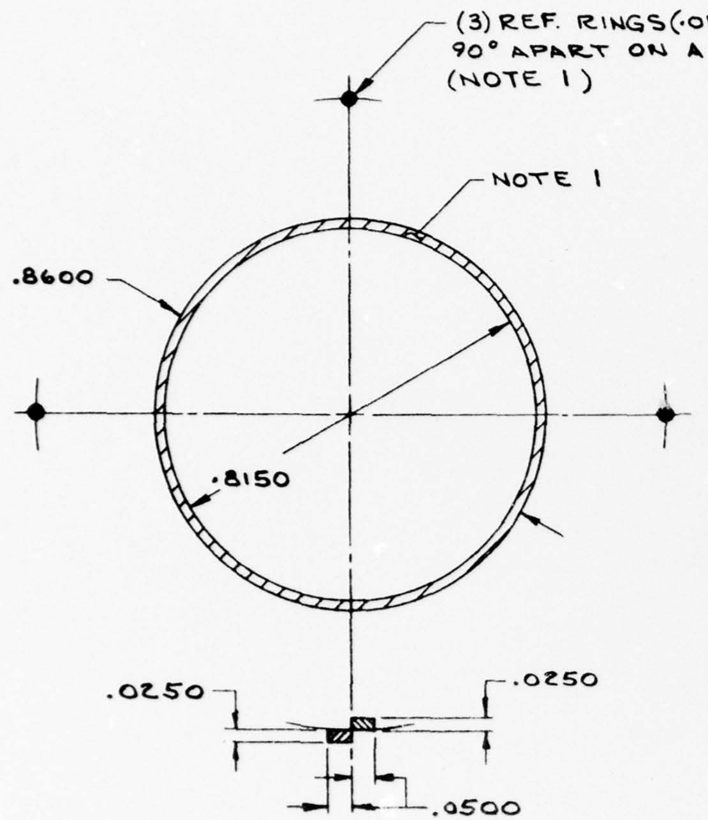
RADIO CORPORATION OF AMERICA — EQUIPMENT DEVELOPMENT

DWG. TITLE: MASK FOR P^+ GATE DIFFUSION

DESIGN BY: S.W. KESSLER 8/5/76 | MODEL NO.: J1537/C

DRAWN BY: S.W. KESSLER 8/5/76 | SIZE: B | DWG. NO.: 3025263R2

T 860 12/56 — DEFIANCE NO. 1050P-8 470



NOTES:

1. CROSS-HATCHED AREA IS CHROME ON MASK (NEG. RESIST)
2. TOL. ON MASK ±.0002 FOR ALL DIM.'S
3. PRINT MASK ON 2" x 2" SLIDES
4. THIS MASK IS REFERRED TO AS MASK 'C' ON PROCESS SHEETS
5. CENTER MASK ON SLIDE WITHIN ± 1/16

REVISIONS	
CHECKED BY	
APPROVED BY	0
REDRAWN; ADDED NOTE 4 — R. Miles Nov. 30, 1976	1
NOTE 3 WAS 2½ x 2½ SLIDES; ADDED NOTE 5 — R. Miles Jan. 21, 1977	2

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STANDARD TOLERANCE		FRAC.	DEC.
BASIC DIM.		FRAC.	DEC.
UP TO 6"	±	1/64	.005
ABOVE 6"	±	1/32	.010
ABOVE 24"	±	1/16	.015
ANGULAR DIM.	±	1/2°	

NOTE: THREADS EXTERNAL, CLASS 2A; INTERNAL, CLASS 2B (AMERICAN STDS) UNLESS OTHERWISE SPECIFIED.

SURFACE ROUGHNESS OF 500 MICRO-INCHES OR STOCK FINISH ACCEPTABLE UNLESS OTHERWISE SPECIFIED.

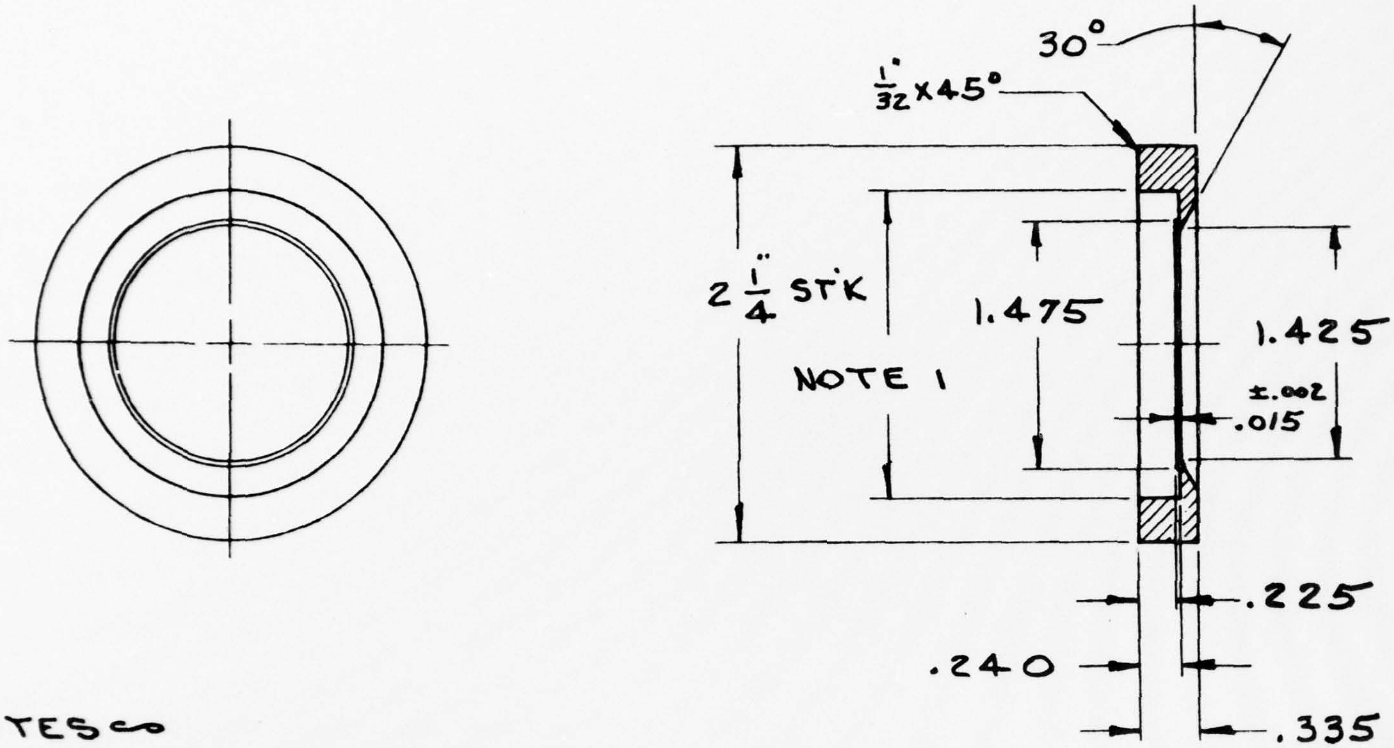
NOTE: SUPPLY ALL SCREWS, NUTS, BOLTS, RIVETS, WASHERS, DOWELS, TAPER PINS, COTTER PINS & WOODRUFF KEYS WITH PART.

MATERIAL	(initials)
PATTERN NO.	
SCALE	4:1
USED ON	
DWG. TITLE	TRIGGER FINGER, ETCH MASK
DESIGN BY	
MODEL NO.	J15371C
DRAWN BY	S.W. KESSLER 8/5/76
SIZE	B
DWG. NO.	3025264R2

RADIO CORPORATION OF AMERICA
EQUIPMENT DEVELOPMENT

T 650 12/55

DEFIANCE NO 1050F-8 470



NOTES:
1. THIS DIA. TO BE A SLIGHT PRESS FIT WITH 1.740 DIA. ON PT. #A3025281

REVISIONS

CHECKED BY	
APPROVED BY	0
ADDED 1/32 x 45° R. Miles 10/19/76	1
1.475 WAS 1.400; 1.425 WAS 1.325; .225 WAS .210; .240 WAS .225 R. Miles Jan. 20, 1977	2

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STANDARD TOLERANCE			
BASIC DIM		FRAC.	DEC.
UP TO 6"	±	1/64	.005
ABOVE 6"	±	1/32	.010
ABOVE 24"	±	1/16	.015
ANGULAR DIM. ± 1/2°			

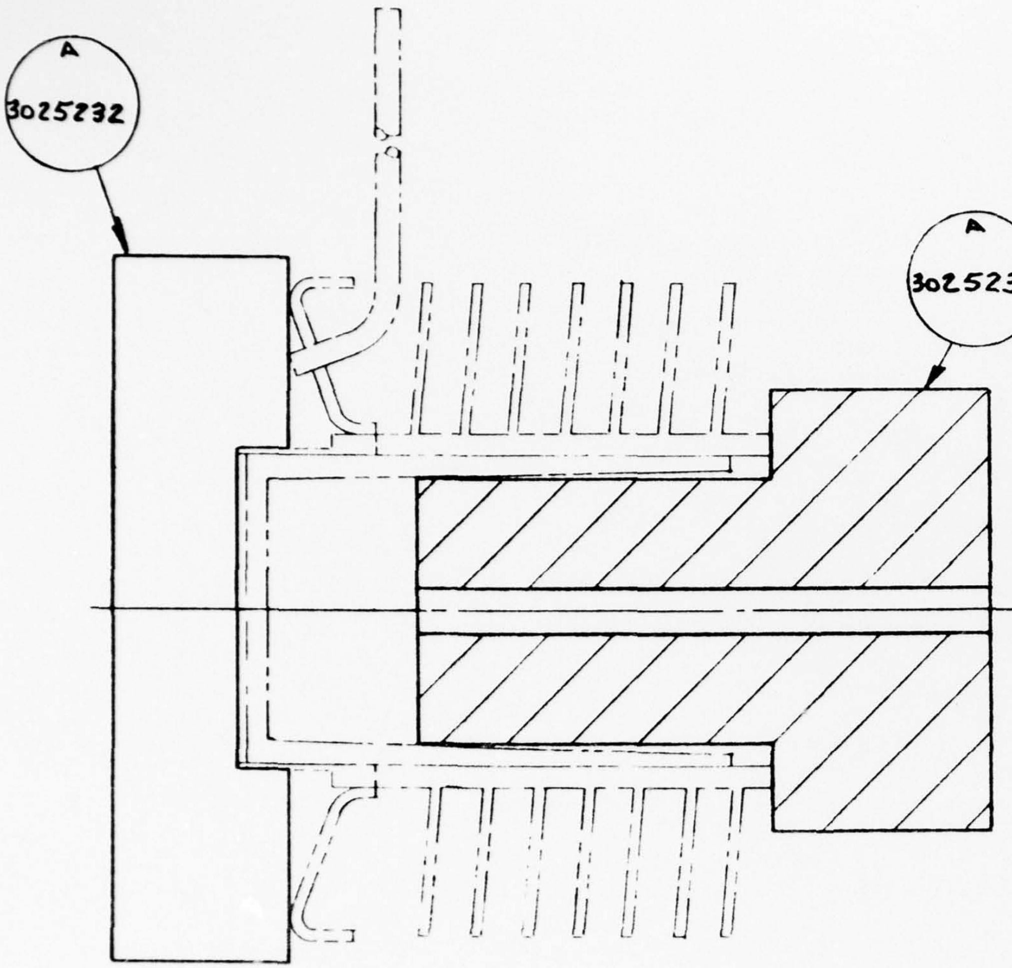
NOTE: THREADS EXTERNAL, CLASS 2A; INTERNAL, CLASS 2B (AMERICAN STDS) UNLESS OTHERWISE SPECIFIED.

SURFACE ROUGHNESS OF 500 MICRO-INCHES OR STOCK FINISH ACCEPTABLE UNLESS OTHERWISE SPECIFIED.

NOTE: SUPPLY ALL SCREWS, NUTS, BOLTS, RIVETS, WASHERS, DOWELS, TAPER PINS, COTTER PINS & WOODRUFF KEYS WITH PART.

MATERIAL: POLYVINYLCHLORIDE (2 1/4" DIA.)	DWG. TITLE: WAFER HOLDER - TOP
PATTERN NO. / SCALE: 1:1 / USED ON	DESIGN BY / MODEL NO. J15371C
RCA Electronic Components ~~EQUIPMENT DEVELOPMENT~~	DRAWN BY: R. Miles Oct. 11, 1976 / SIZE: A / DWG. NO. 3025282R2

BRUNING 40-22 11030



REVISIONS	
CHECKED BY	
APPROVED BY	0
A3025231 WAS A3025288-2 R. Miles Jan. 25, 1977	1

~USE FOR ASS'Y #3025271~

THESE DRAWINGS AND SPECIFICATIONS ARE THE PROPERTY OF RCA CORPORATION AND ARE NOT TO BE REPRODUCED OR COPIED OR USED AS THE BASIS FOR THE MANUFACTURE OR SALE OF APPARATUS AND OR DEVICES WITHOUT PERMISSION

STANDARD TOLERANCE			
BASIC DIM		FRAC	DEC
UP TO 6"	±	1/64	.005
ABOVE 6"	±	1/32	.010
ABOVE 24"	±	1/16	.015
ANGULAR DIM ± 1/2°			

NOTE: THREADS EXTERNAL, CLASS 2A; INTERNAL, CLASS 2B (AMERICAN STDS) UNLESS OTHERWISE SPECIFIED

SURFACE ROUGHNESS OF 500 MICRO INCHES OR STOCK FINISH ACCEPTABLE UNLESS OTHERWISE SPECIFIED

NOTE: SUPPLY ALL SCREWS, NUTS, BOLTS, RIVETS, WASHERS, DOWELS, TAPER PINS, COTTER PINS & WOODRUFF KEYS WITH PART

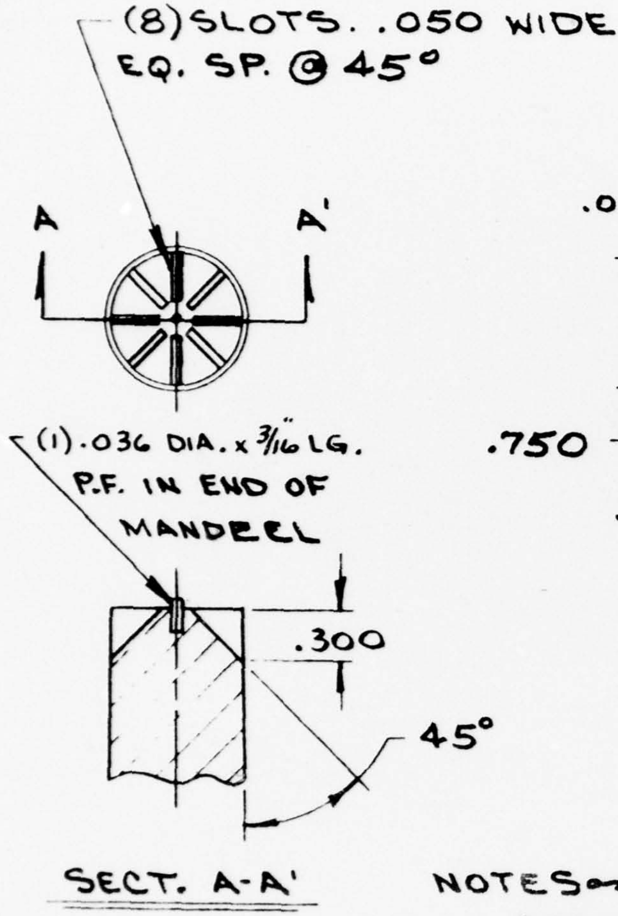
MATERIAL: CRS			DWG. TITLE: ANODE BODY BRAZING FIXT.
PATTERN NO.	SCALE: 2:1	USED ON	DESIGN BY
RCA Electronic Components ~~EQUIPMENT DEVELOPMENT~~			DRAWN BY: R. Miles Sept. 8, 1976

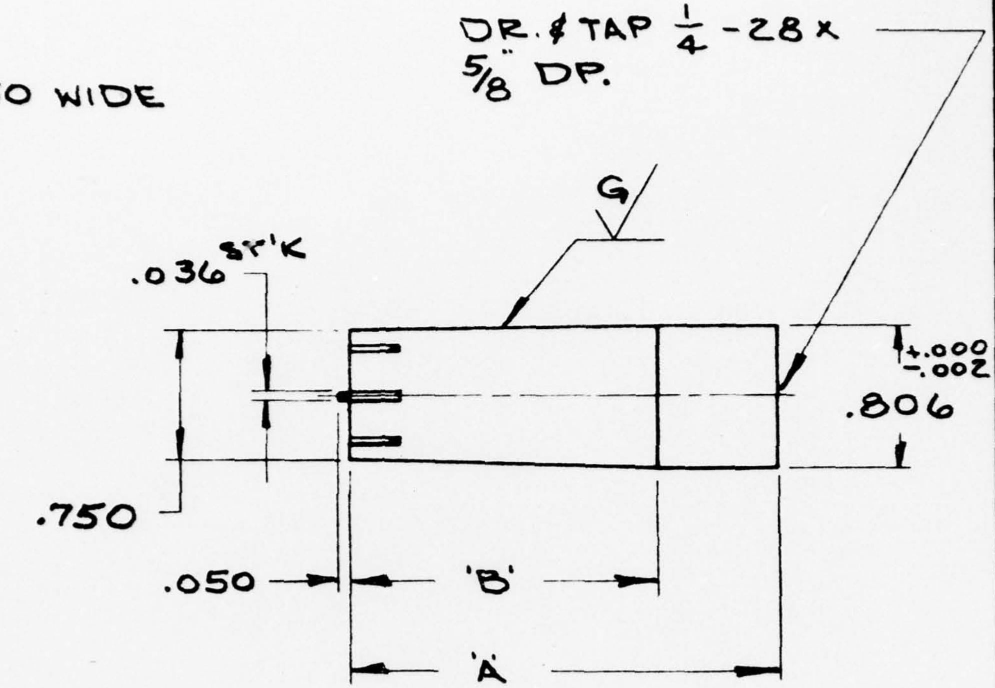
MODEL NO. J15371C

SIZE A DWG. NO. 3025287R1

BRUNING 40-22 11838

T659 8/69





PART NO.	'A'	'B'
3025288-1	2.435	1.700
3025288-2	2.050	1.312

NOTES:

1. COAT WITH BLACK EMISSIVITY COATING PER SCHED. B-1

REVISIONS	
CHECKED BY	
APPROVED BY	0
DIM. 'B', PT. 1 WAS 1.750; .750 WAS .735; .806 WAS .804 R. Miles Jan. 20, 1977	1

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STANDARD TOLERANCE			
BASIC DIM		FRAC.	DEC.
UP TO 6"	±	1/64	.005
ABOVE 6"	±	1/32	.010
ABOVE 24"	±	1/16	.015
ANGULAR DIM ± 1/2°			

NOTE: THREADS EXTERNAL, CLASS 2A; INTERNAL, CLASS 2B (AMERICAN STDS) UNLESS OTHERWISE SPECIFIED.

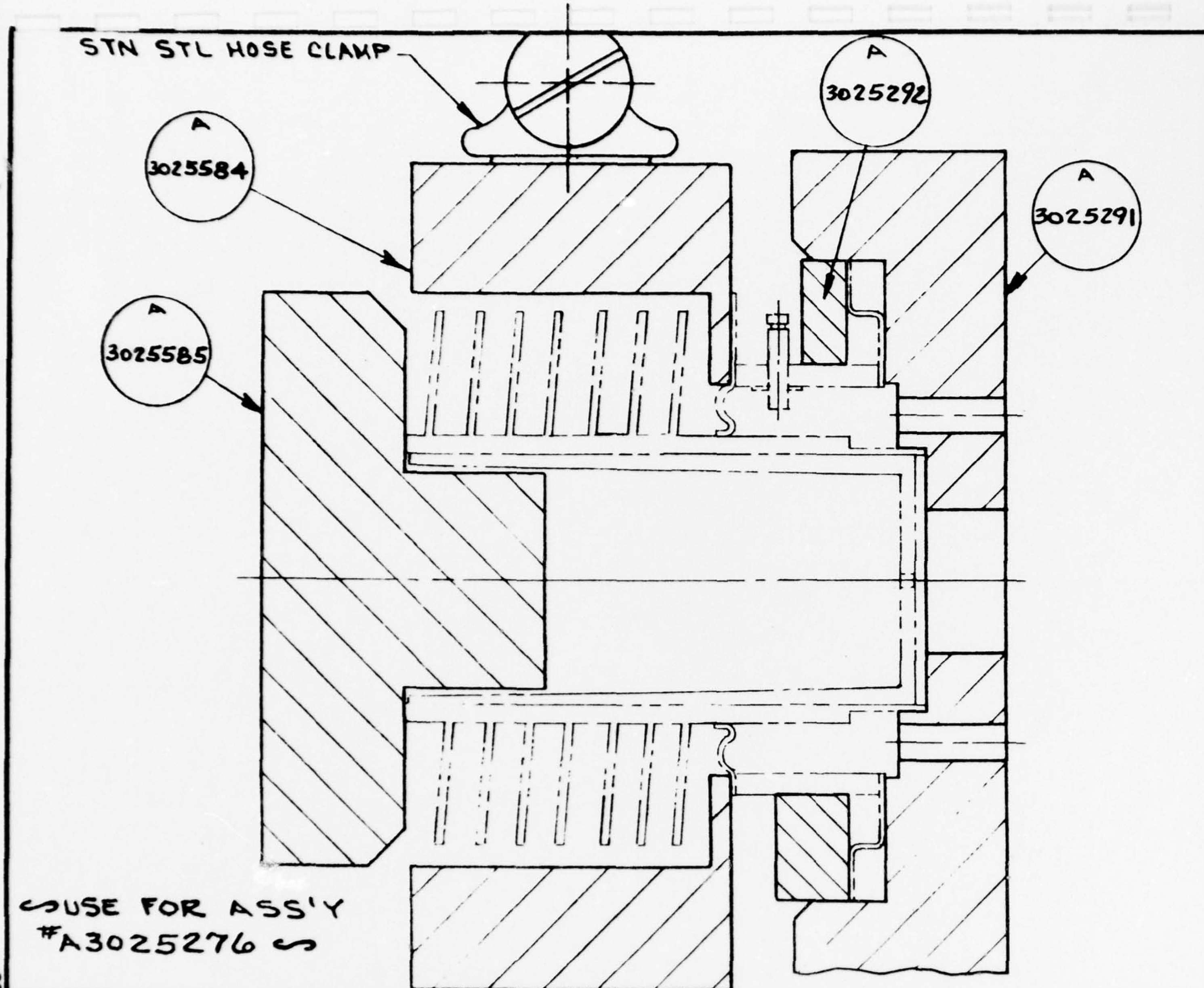
SURFACE ROUGHNESS OF 500 MICRO-INCHES OR STOCK FINISH ACCEPTABLE UNLESS OTHERWISE SPECIFIED.

NOTE: SUPPLY ALL SCREWS, NUTS, BOLTS, RIVETS, WASHERS, DOWELS, TAPER PINS, COTTER PINS & WOODRUFF KEYS WITH PART.

MATERIAL	304 STN STL
DWG. TITLE	WICKING MANDREL
PATTERN NO.	
SCALE	1:1
USED ON	
DESIGN BY	
MODEL NO.	J15371C
	RCA Electronic Components ~~EQUIPMENT DEVELOPMENT~~
DRAWN BY	R. Miles Sept. 10, 1976
SIZE	A
DWG. NO.	3025288R1

T659 8 69

BRUNING 40-22 11838



REVISIONS	
CHECKED BY	
APPROVED BY	0
DELETED A3025288-1 ADDED A3025584 & A3025585 R. Miles Jan. 25, 1977	1

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STANDARD TOLERANCE		FRAC.	DEC.
BASIC DIM			
UP TO 6"	±	1/64	.005
ABOVE 6"	±	1/32	.010
ABOVE 24"	±	1/16	.015
ANGULAR DIM ± 1/2°			

NOTE: THREADS EXTERNAL, CLASS 2A. INTERNAL, CLASS 2B (AMERICAN STDS) UNLESS OTHERWISE SPECIFIED

SURFACE ROUGHNESS OF 500 MICRO-INCHES OR STOCK FINISH ACCEPTABLE UNLESS OTHERWISE SPECIFIED

NOTE: SUPPLY ALL SCREWS, NUTS, BOLTS, RIVETS, WASHERS, DOWELS, TAPER PINS, COTTER PINS & WOODRUFF KEYS WITH PART

MATERIAL: CH

PATTERN NO. | SCALE: 2:1 | USED ON

RCA Electronic Components — ~~EQUIPMENT DEVELOPMENT~~

DWG. TITLE: CATHODE BODY BRAZING FIXT.

DESIGN BY

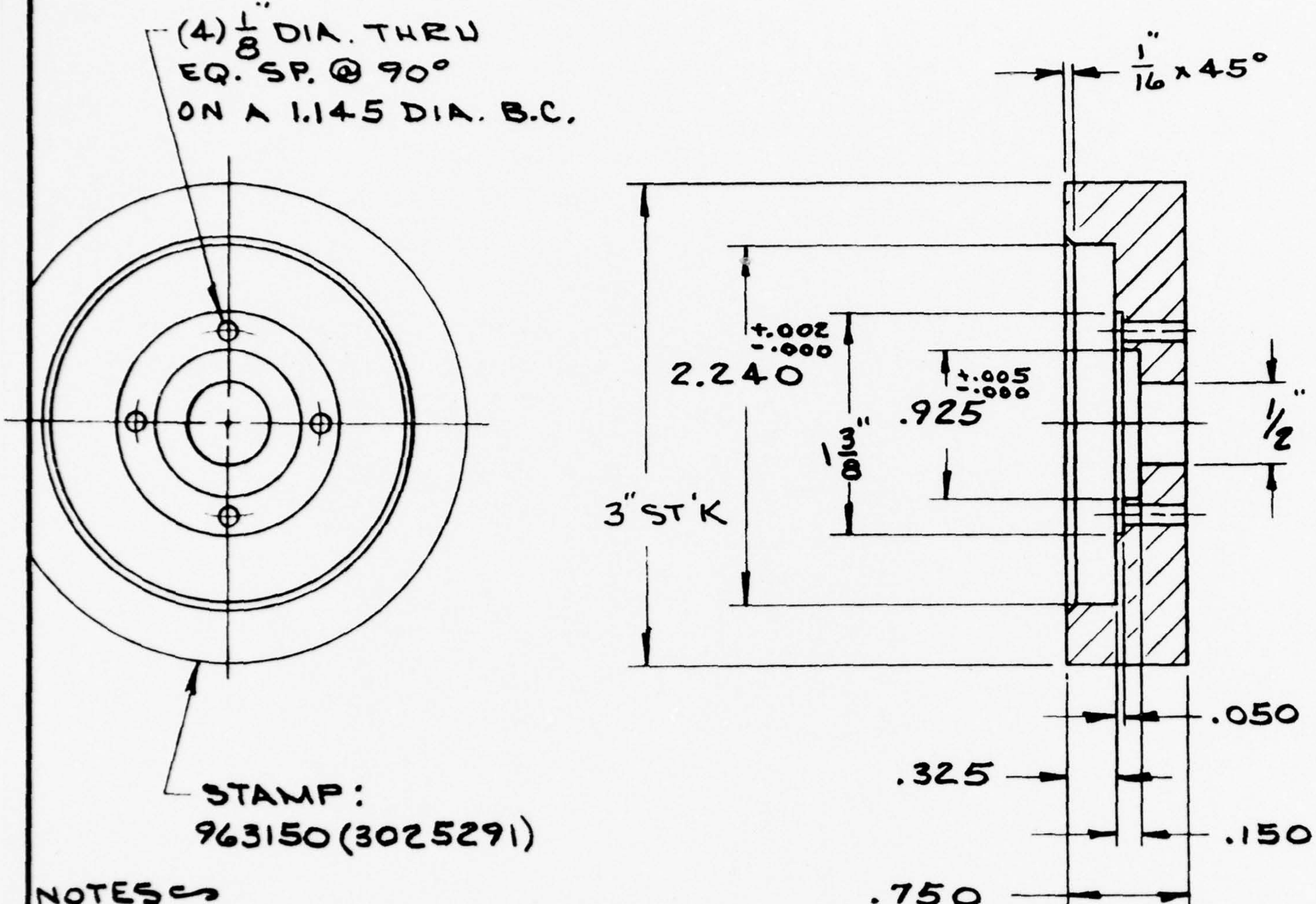
MODEL NO.: J15371C

DRAWN BY: R. Miles Sept. 9, 1976

SIZE: A — DWG. NO.: 3025290R1

T659 8/69

BRUNING 40-22 11838



NOTES
1. COAT WITH BLACK EMISSIVITY COATING PER SCHED. B-1

REVISIONS	
CHECKED BY	
APPROVED BY	0
.925 WAS .918; ADDED 2.240 +.002 -.000 — R. Miles Jan. 20, 1977	1

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STANDARD TOLERANCE			
BASIC DIM		FRAC	DEC
UP TO 6"	±	1/64	.005
ABOVE 6"	±	1/32	.010
ABOVE 24"	±	1/16	.015
ANGULAR DIM ± 1/2°			

NOTE: THREADS EXTERNAL, CLASS 2A; INTERNAL, CLASS 2B (AMERICAN STDS) UNLESS OTHERWISE SPECIFIED

SURFACE ROUGHNESS OF 500 MICRO INCHES OR STOCK FINISH ACCEPTABLE UNLESS OTHERWISE SPECIFIED

NOTE: SUPPLY ALL SCREWS, NUTS, BOLTS, RIVETS, WASHERS, DOWELS, TAPER PINS, COTTER PINS & WOODRUFF KEYS WITH PART

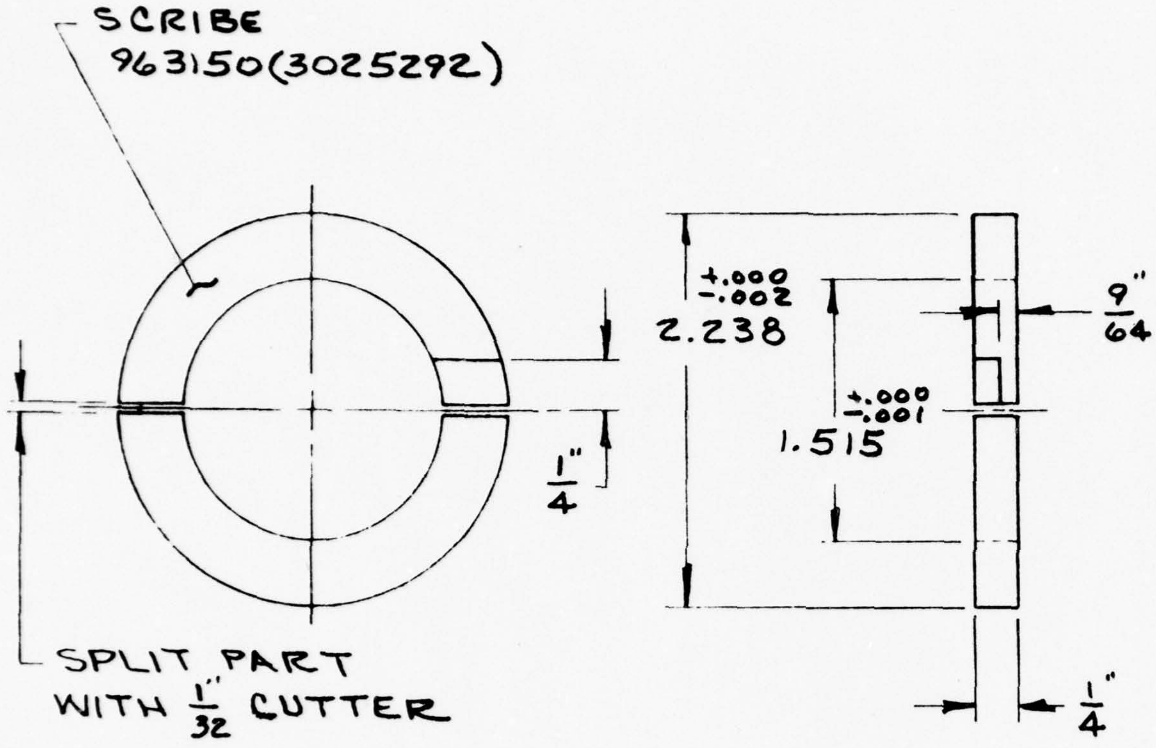
MATERIAL 304 STN STL			DWG. TITLE BASE
PATTERN NO.	SCALE 1:1	USED ON	DESIGN BY
RCA Electronic Components EQUIPMENT DEVELOPMENT			DRAWN BY R. Miles Sept. 9, 1976

MODEL NO. J15371C

SIZE A DWG. NO. 3025291R1

BRUNING 40-22 11838

T659 8/69



NOTES:
1. COAT WITH BLACK EMISSIVITY COATING PER SCHED. B1

REVISIONS	
CHECKED BY	
APPROVED BY	0
1.515 +.000/-.001 WAS 1.500 ±.005; 2.238 +.000/-.002 WAS 2.230 ±.005 R. Miles Jan. 20, 1977	1

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STANDARD TOLERANCE			
BASIC DIM		FRAC.	DEC
UP TO 6"	±	1/64	.005
ABOVE 6"	±	1/32	.010
ABOVE 24"	±	1/16	.015
ANGULAR DIM ± 1/2°			

NOTE: THREADS EXTERNAL, CLASS 2A INTERNAL, CLASS 2B (AMERICAN STDS) UNLESS OTHERWISE SPECIFIED

SURFACE ROUGHNESS OF 500 MICRO-INCHES OR STOCK FINISH ACCEPTABLE UNLESS OTHERWISE SPECIFIED

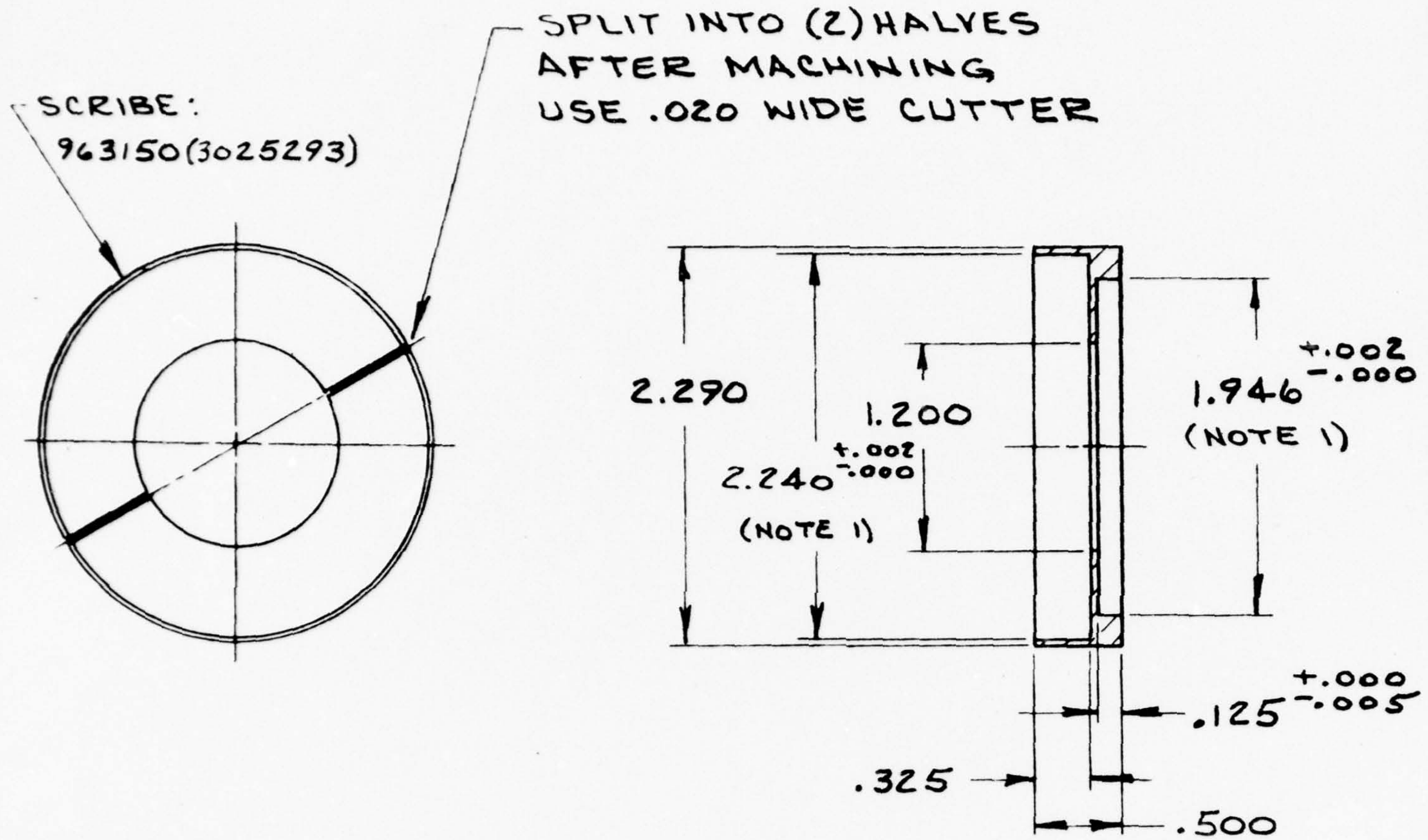
NOTE: SUPPLY ALL SCREWS, NUTS, BOLTS, RIVETS, WASHERS, DOWELS, TAPER PINS, COTTER PINS & WOODRUFF KEYS WITH PART

MATERIAL	304 STN STL
DWG. TITLE	CENTERING RING
PATTERN NO.	
SCALE	1:1
USED ON	
DESIGN BY	
MODEL NO.	J15371C
DRAWN BY	R. Miles Sept. 9, 1976
SIZE	A
DWG NO.	3025292R1

RCA Electronic Components — ~~EQUIPMENT DEVELOPMENT~~

BRUNING 40-22 11838

T659 8/69



NOTES:

1. RUNOUT BETWEEN DIA.'S INDICATED NOT TO EXCEED .002
2. COAT WITH BLACK EMISSIVITY COATING PER SCHED. B-1

REVISIONS	
CHECKED BY	
APPROVED BY	0
.125 WAS ±.005; ADDED 2.240 +.002 -.000 R. Miles Jan. 20, 1977	1

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STANDARD TOLERANCE			
BASIC DIM		FRAC	DEC
UP TO 6"	±	1/64	.005
ABOVE 6"	±	1/32	.010
ABOVE 24"	±	1/16	.015
ANGULAR DIM ± 1/2°			

NOTE: THREADS EXTERNAL, CLASS 2A; INTERNAL, CLASS 2B (AMERICAN STDS) UNLESS OTHERWISE SPECIFIED.

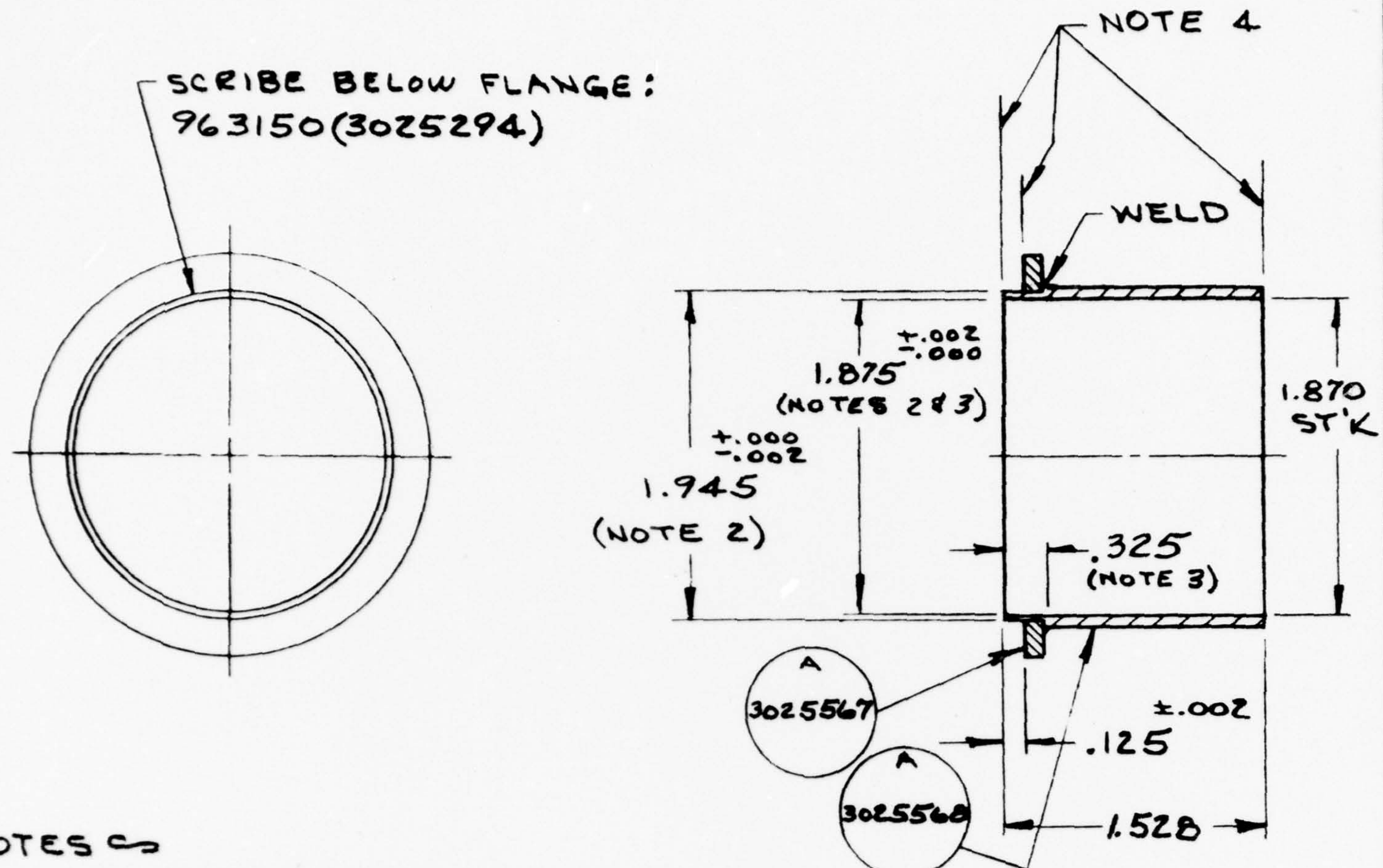
SURFACE ROUGHNESS OF 500 MICRO-INCHES OR STOCK FINISH ACCEPTABLE UNLESS OTHERWISE SPECIFIED

NOTE: SUPPLY ALL SCREWS, NUTS, BOLTS, RIVETS, WASHERS, DOWELS, TAPER PINS, COTTER PINS & WOODRUFF KEYS WITH PART

MATERIAL 304 STN STL			DWG. TITLE SPLIT RING	
PATTERN NO.	SCALE 1:1	USED ON	DESIGN BY	MODEL NO. J15371C
RCA Electronic Components ~~EQUIPMENT DEVELOPMENT~~			DRAWN BY R. Miles Oct. 20, 1976	SIZE A DWG. NO. 3025293R1

BRUNING 40-22 11838

T659 8/69



NOTES:
1. WELD BEFORE MACHINING
2. RUNOUT BETWEEN DIA.'S INDICATED NOT TO EXCEED .002
3. TOL. TO BE HELD OVER LENGTH SHOWN
4. SURFACES TO BE PARALLEL & PERPENDICULAR TO ℄
5. COAT WITH BLACK EMISSIVITY COATING PER SCHED. B-1

REVISIONS	
CHECKED BY	
APPROVED BY	0
.125 WAS ±.005; .325 WAS .250 — R. Miles Jan. 20, 1977	1

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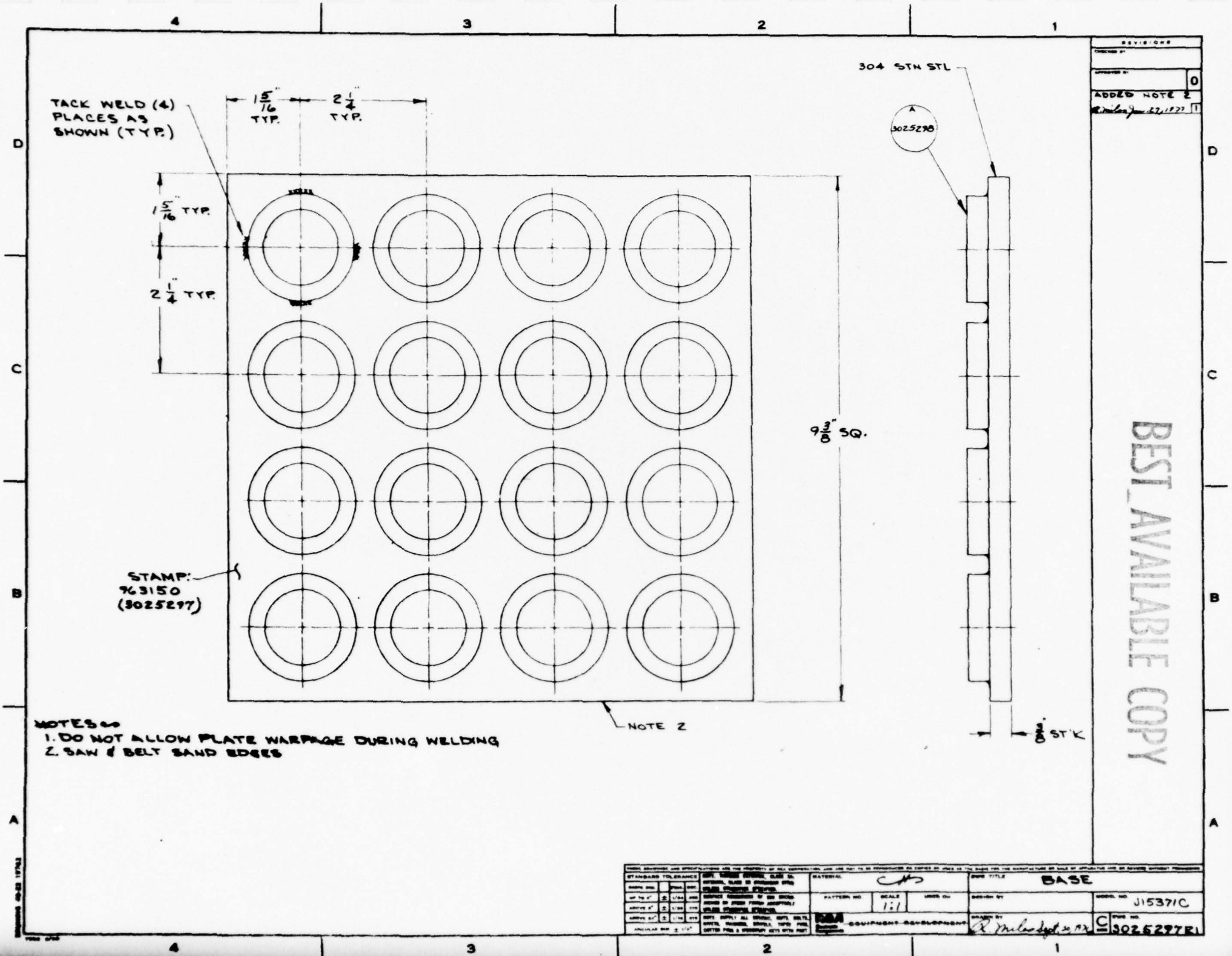
STANDARD TOLERANCE			
BASIC DIM		FRAC	DEC
UP TO 6"	±	1/64	.005
ABOVE 6"	±	1/32	.010
ABOVE 24"	±	1/16	.015
ANGULAR DIM ± 1/2°			

NOTE: THREADS EXTERNAL, CLASS 2A; INTERNAL, CLASS 2B (AMERICAN STDS) UNLESS OTHERWISE SPECIFIED.
SURFACE ROUGHNESS OF 500 MICRO-INCHES OR STOCK FINISH ACCEPTABLE UNLESS OTHERWISE SPECIFIED.
NOTE: SUPPLY ALL SCREWS, NUTS, BOLTS, RIVETS, WASHERS, DOWELS, TAPER PINS, COTTER PINS & WOODRUFF KEYS WITH PART.

MATERIAL	H
PATTERN NO.	
SCALE	1:1
USED ON	
DWG. TITLE	SLEEVE ASS'Y
DESIGN BY	
MODEL NO.	J15371C
DRAWN BY	R. Miles Oct. 20, 1976
SIZE	A
DWG. NO.	3025294 R1

RCA Electronic Components ~~EQUIPMENT DEVELOPMENT~~

BRUNING 40-22 11838
T659 8/69



NOTES:
1. DO NOT ALLOW PLATE WARPAGE DURING WELDING
2. SAW & BELT SAND EDGES

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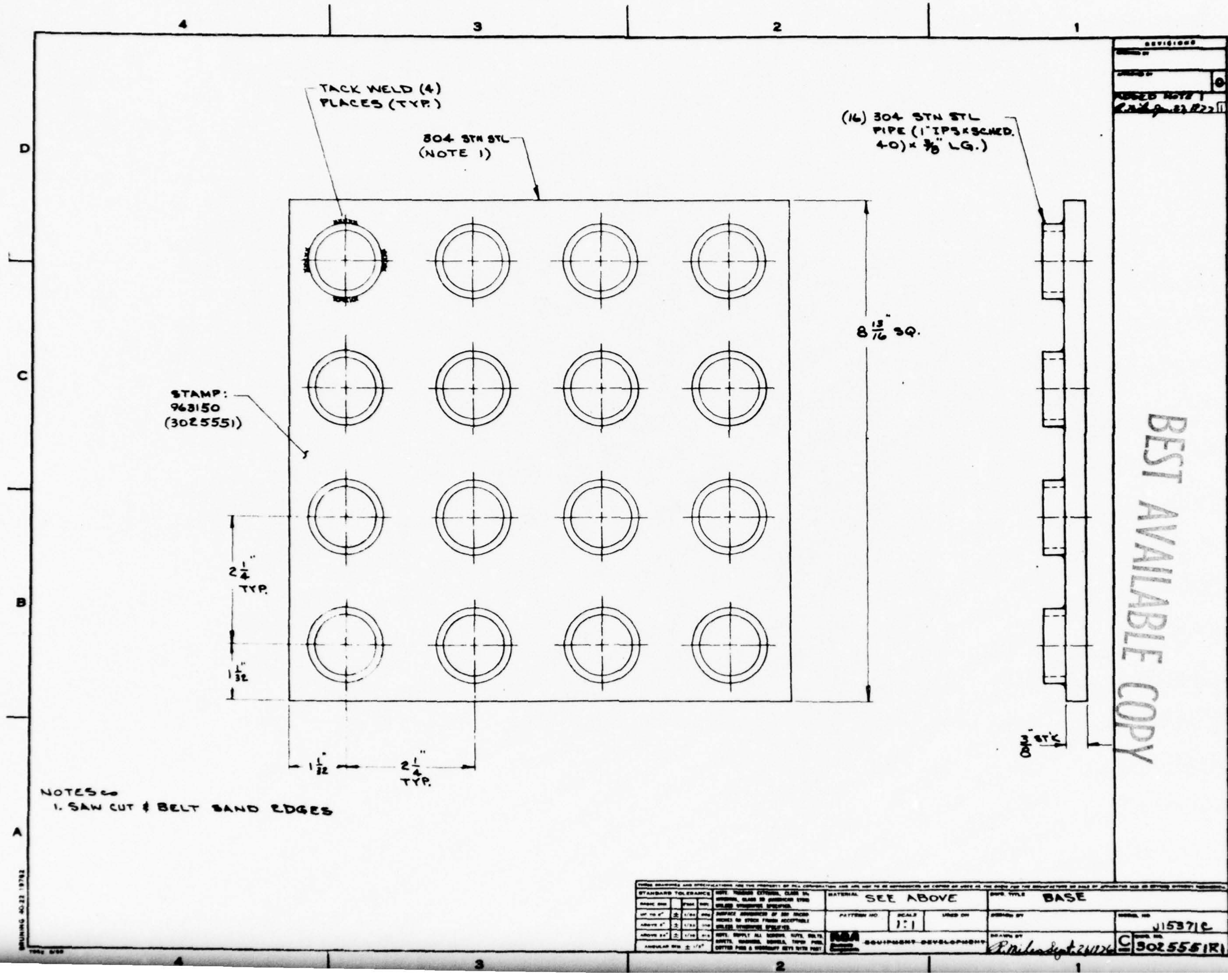

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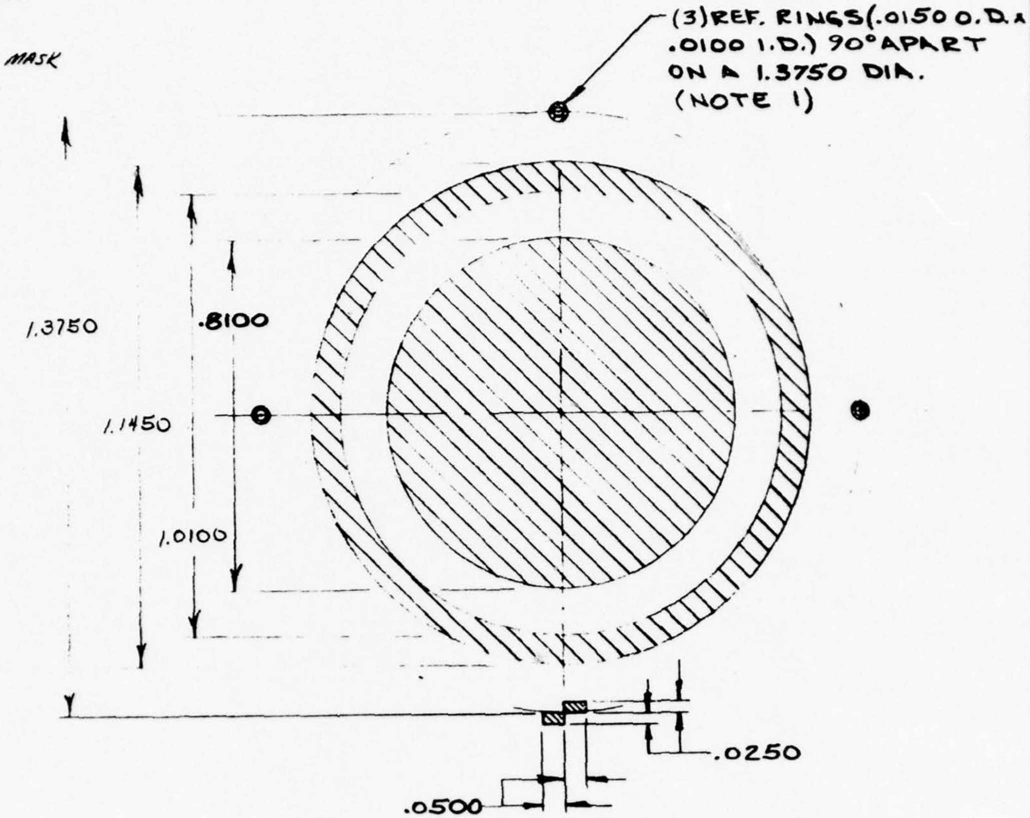
DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING. DO NOT SCALE DRAWING. ALL EXTERNAL THREADS TO BE CLASS 2A BEFORE PLATING AND CLASS 2 AFTER PLATING. ALL INTERNAL THREADS TO BE CLASS 2B, UNLESS OTHERWISE SPECIFIED.

NOTES:

1. AREA CROSS HATCHED IS OPAQUE ON MASK
2. PRINT MASK IN CENTER OF A 2"x2" GLASS SLIDE WITHIN ± 1/16"
3. TOLERANCE ON MASK ARE ±.0002 FOR ALL DIMENSIONS
4. THIS MASK IS REFERRED TO AS MASK 'D' ON PROCESS SHEETS



REVISIONS

AP. BY	DATE	
DWG. NO. WAS 9638100-4; NOTE 3 WAS ±.0001; ADDED NOTE 4	R. Miles Dec. 1, 1976	1
.8100 WAS .8000; NOTE 2 ADDED "WITHIN ± 1/16"; (3) REF. RINGS, ETC. WAS (4); ADDED (2) RECT. .0250 x .0500	R. Miles Jan. 24, 1977	2

VARIATIONS ON FINISHED DIMENSIONS UNLESS OTHERWISE MARKED		
BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	± .02	± .005
ABOVE 6 TO 24	± .03	± .010
ABOVE 24	± .06	± .015
ANGULAR DIMENSIONS ± 1/2 DEG.		
SEE PURCH. SPEC. FOR STOCK TOLERANCE		

EMITTER-GATE INSULATION MASK

400 AMP TRANSCALENT THYRISTOR

FIRST MADE FOR | USED ON

DRAWN BY S.W. Kessler | CHECKED BY

DESIGNED BY S.W. Kessler | COMMODITY CODE

RCA — RCA CORPORATION — Sept 25, 1972

CODE IDENT NO. 49671

SIZE B — 3025553A R2 — SHEET — CONT'D ON SH

3025553AR2

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RCA 406-2 REV. 1 9-69 PRINTED IN U.S.A.

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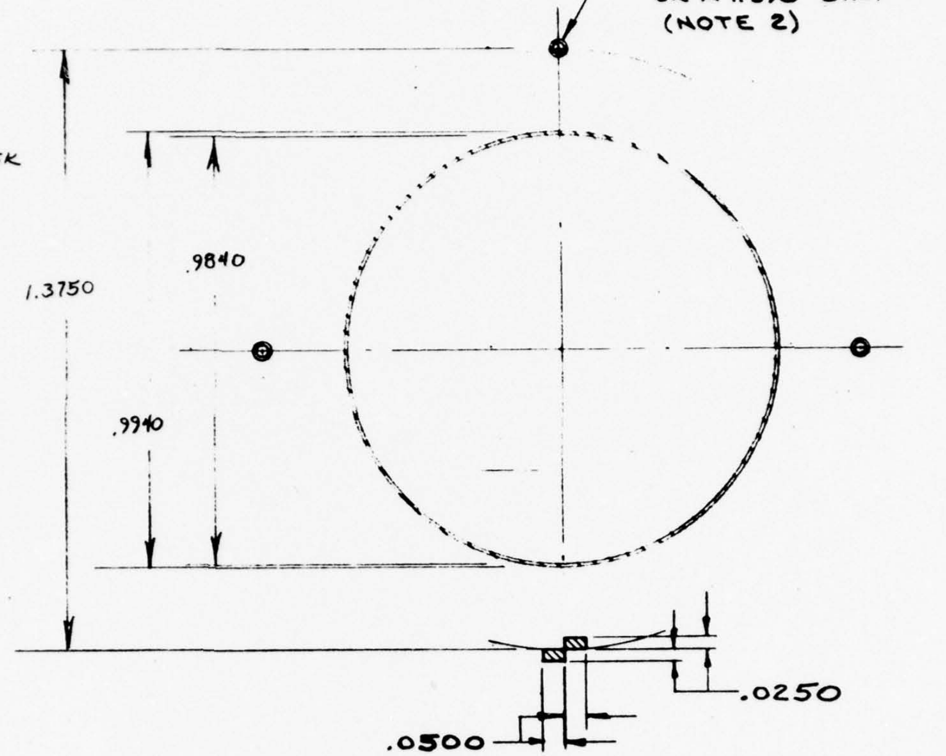
DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING. DO NOT SCALE DRAWING. ALL EXTERNAL THREADS TO BE CLASS 2A BEFORE PLATING AND CLASS 2 AFTER PLATING. ALL INTERNAL THREADS TO BE CLASS 2B, UNLESS OTHERWISE SPECIFIED.

NOTES:
1. THIS MASK IS REFERRED TO AS MASK 'E' ON PROCESS SHEETS
2. AREA CROSS HATCHED IS OPAQUE ON MASK
3. PRINT MASK IN CENTER OF A 2" x 2" GLASS SLIDE WITHIN ± 1/16"
4. TOLERANCES ON MASK ARE ±.0002 FOR ALL DIMENSIONS.



REVISIONS		
AP. BY		0
DATE		
NOTE 1 WAS: SELECT RUBYLITH CUTTING SO THAT ALL AREA OUTSIDE A DIA. OF 1.0950 MAY BE OPAQUE IN A FUTURE DWG. WITH THE RING SHOWN IN THIS DWG. ON IT.; NOTE 4 WAS ±.0001; DWG. NO. WAS 9638100-5 R. Miles Dec. 1, 1972		1
NOTE 2 ADDED "WITHIN ± 1/16"; (3) REF. RINGS, ETC. WAS (4); ADDED (2) RECT. .0250 x .0500 R. Miles Jan. 24, 1973		2

VARIATIONS ON FINISHED DIMENSIONS UNLESS OTHERWISE MARKED		
BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	± .02	± .005
ABOVE 6 TO 24	± .03	± .010
ABOVE 24	± .06	± .015
ANGULAR DIMENSIONS ± 1/2 DEG		
SEE PURCH. SPEC. FOR STOCK TOLERANCE		

EMITTER METALLIZING ETCH MASK
400 AMP TRANSCALENT THYRISTOR

FIRST MADE FOR
USED ON
DRAWN BY S.H. Kessler
CHECKED BY
DESIGNED BY S.H. Kessler
COMMODITY CODE
RCA
RCA CORPORATION
Sept 25, 1972
CODE IDENT NO. 49671
SIZE B
3025554A R2
SHEET
CONT'D ON SH

3025554AR2

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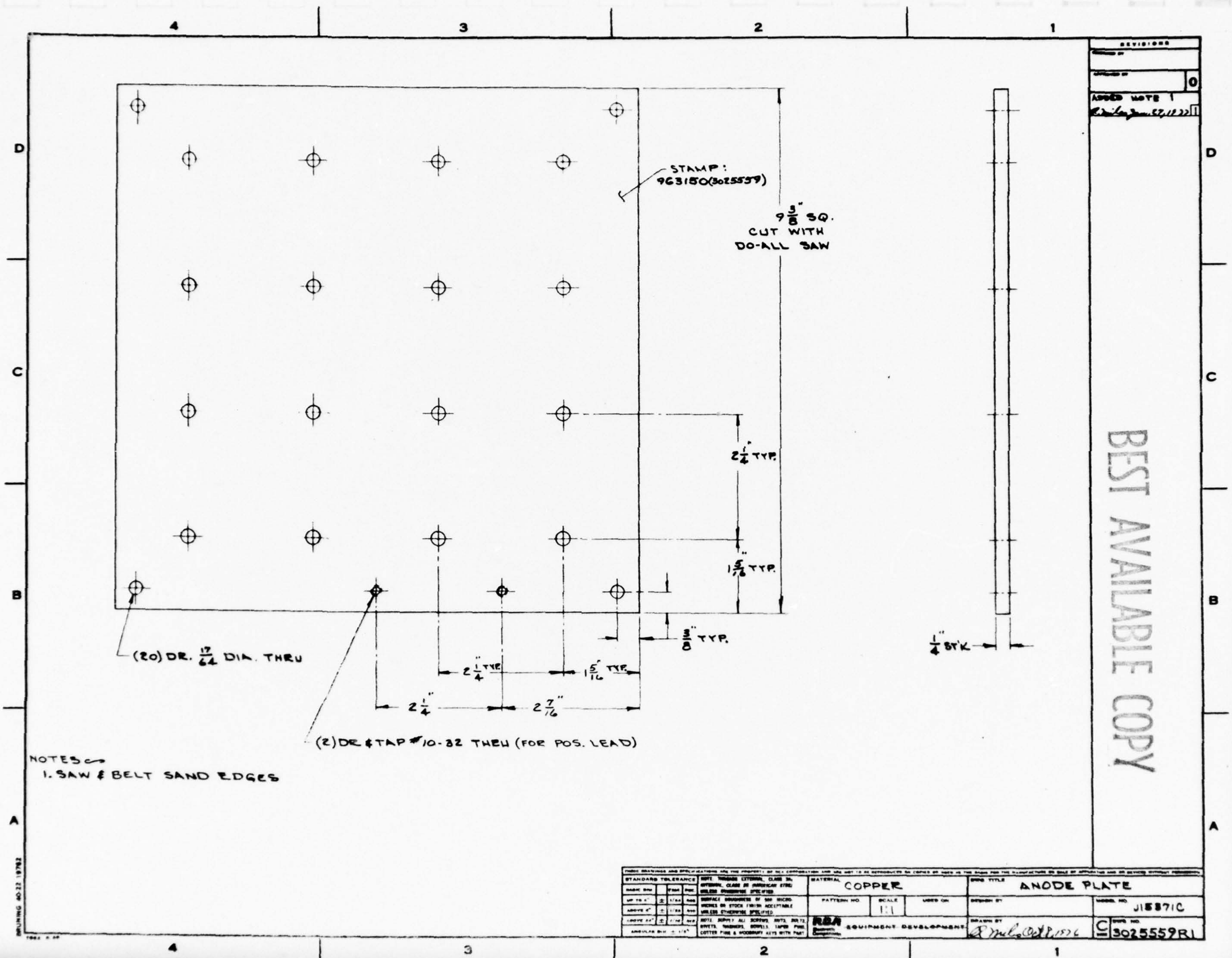
RCA 400-2 REV. 1 9-69 PRINTED IN U.S.A.



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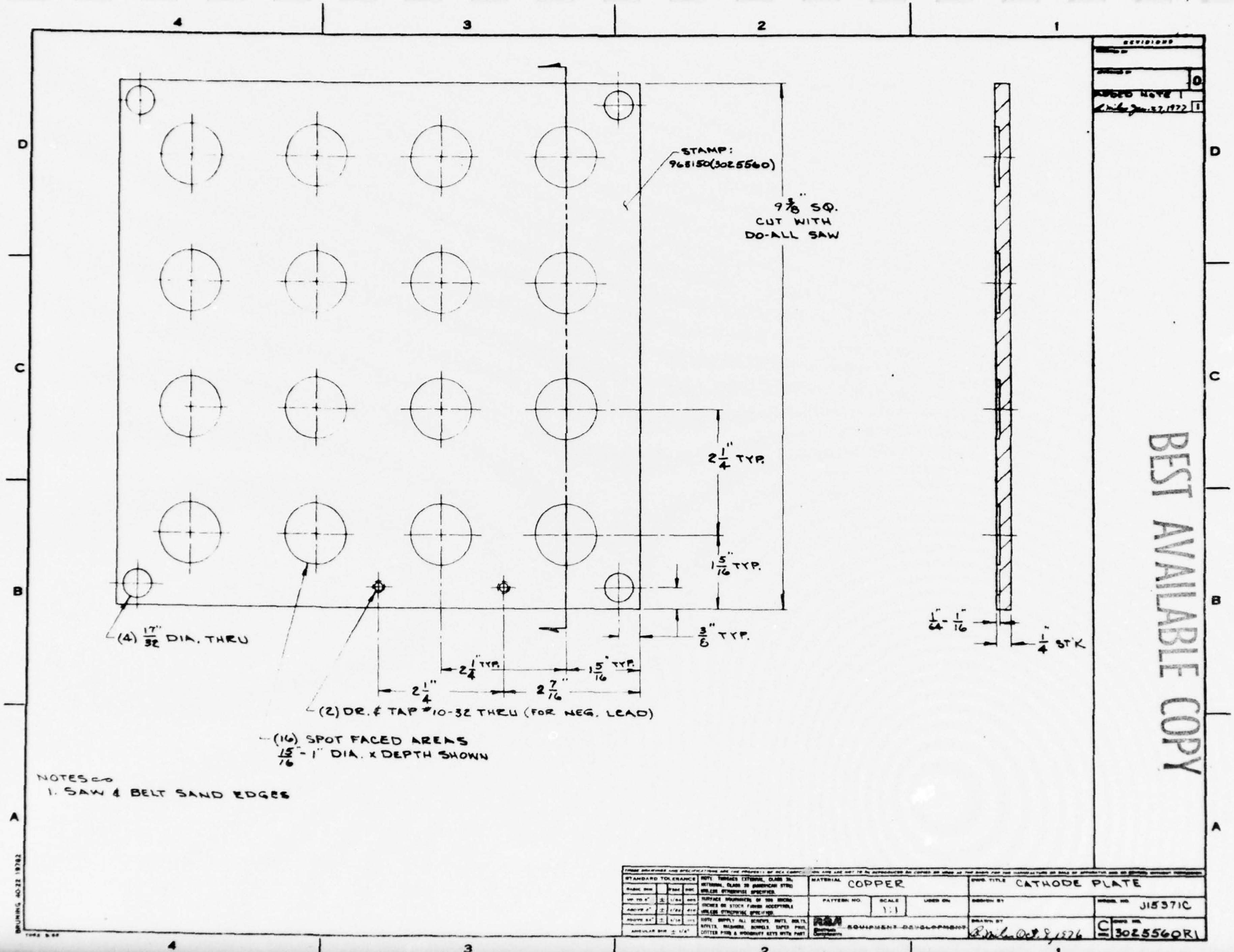
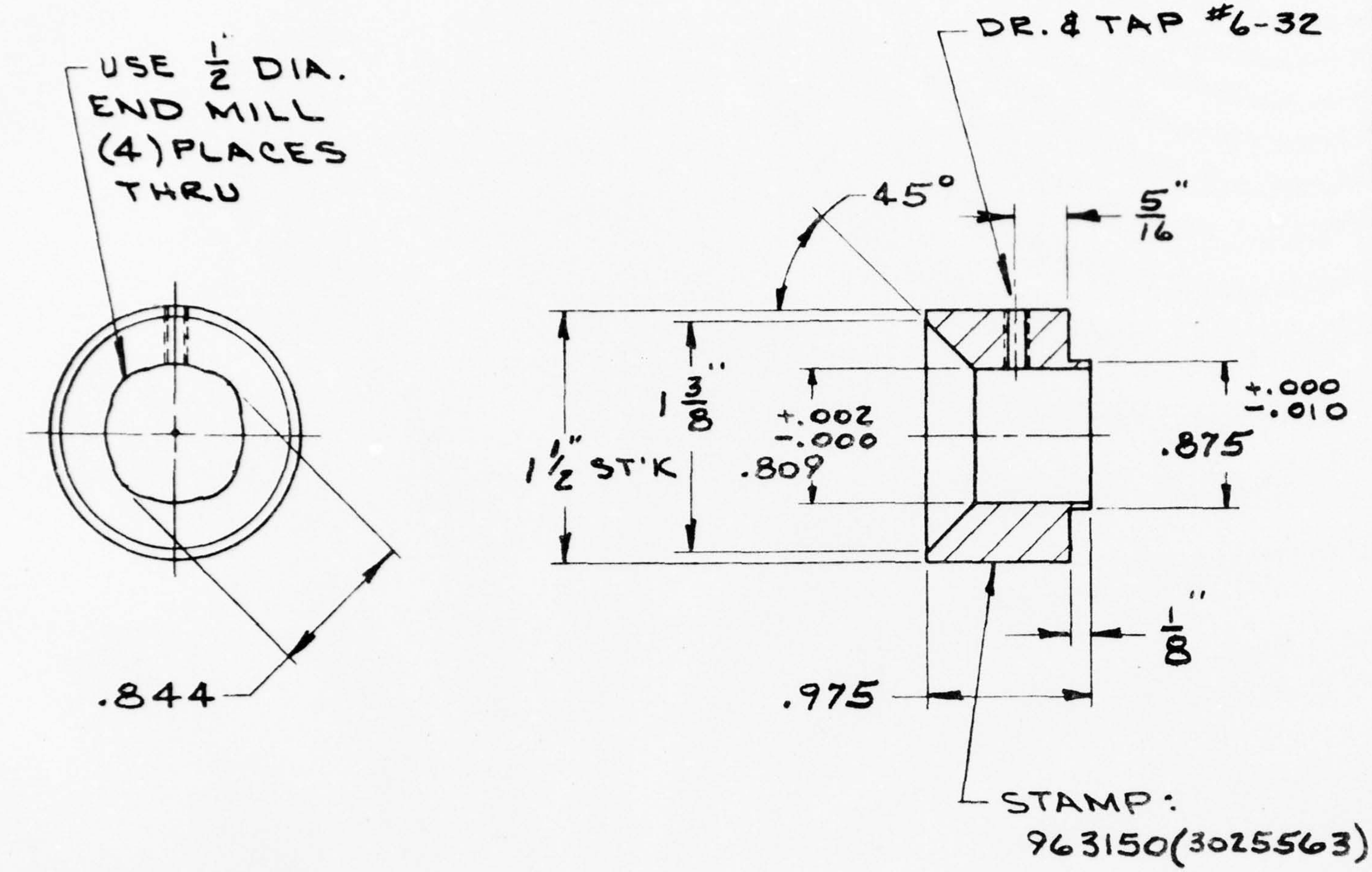

STAMP: 968150(3025560)
9 3/8" SQ. CUT WITH DO-ALL SAW
2 1/4" TYP.
1 5/16" TYP.
3/8" TYP.
(4) 17/32" DIA. THRU
2 1/4" TYP.
1 5/16" TYP.
2 1/4"
2 7/16"
(2) DR. & TAP #10-32 THRU (FOR NEG. LEAD)
(16) SPOT FACED AREAS 15/16"-1" DIA. x DEPTH SHOWN
NOTES:
1. SAW & BELT SAND EDGES
1/64"-1/16"
1/4" ST'K
BEST AVAILABLE COPY
REVISIONS
ADDED NOTE 1
MATERIAL COPPER
SCALE 1:1
DWG. TITLE CATHODE PLATE
J15371C
C 3025560R1
RCA EQUIPMENT DEVELOPMENT



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CHECKED BY	
APPROVED BY	0
.809 +.002 −.000 WAS .812 ±.005 R. Miles Jan. 20, 1977	1

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STANDARD TOLERANCE			
BASIC DIM		FRAC	DEC
UP TO 6"	±	1/64	.005
ABOVE 6"	±	1/32	.010
ABOVE 24"	±	1/16	.015
ANGULAR DIM. ± 1/2°			

NOTE: THREADS EXTERNAL, CLASS 2A; INTERNAL, CLASS 2B (AMERICAN STDS) UNLESS OTHERWISE SPECIFIED.

SURFACE ROUGHNESS OF 500 MICRO-INCHES OR STOCK FINISH ACCEPTABLE UNLESS OTHERWISE SPECIFIED.

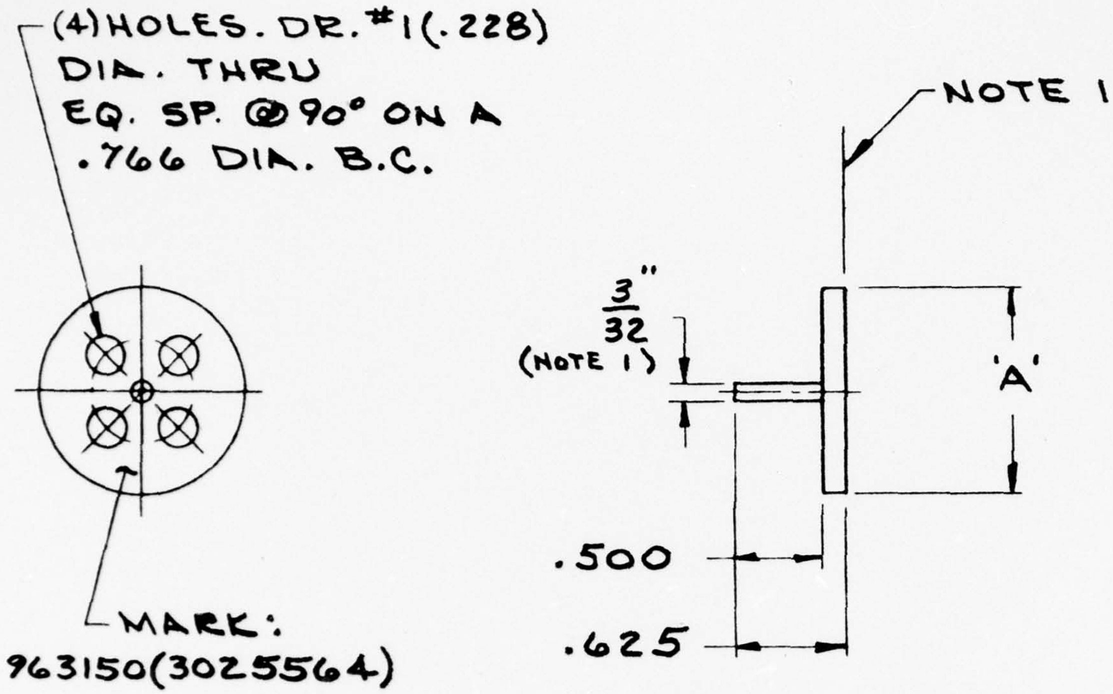
NOTE: SUPPLY ALL SCREWS, NUTS, BOLTS, RIVETS, WASHERS, DOWELS, TAPER PINS, COTTER PINS & WOODRUFF KEYS WITH PART.

MATERIAL	C.R.S. (1 1/2" DIA.)
PATTERN NO.	
SCALE	1:1
USED ON	
DWG. TITLE	WICKING FUNNEL
DESIGN BY	
MODEL NO.	J15371C
DRAWN BY	R. Miles Oct. 15, 1976
SIZE	A
DWG. NO.	3025563R1

RCA Electronic Components ~~EQUIPMENT DEVELOPMENT~~

BRUNING 40-22 11838

REVISIONS	
CHECKED BY	
APPROVED BY	0
ADDED PT. 2 R. Miles Jan. 26, 1977	1



NOTES:
1. SURFACE MUST BE PERPENDICULAR TO SHAFT

PART NO.	'A'
3025564-1	1.170
3025564-2	1.145

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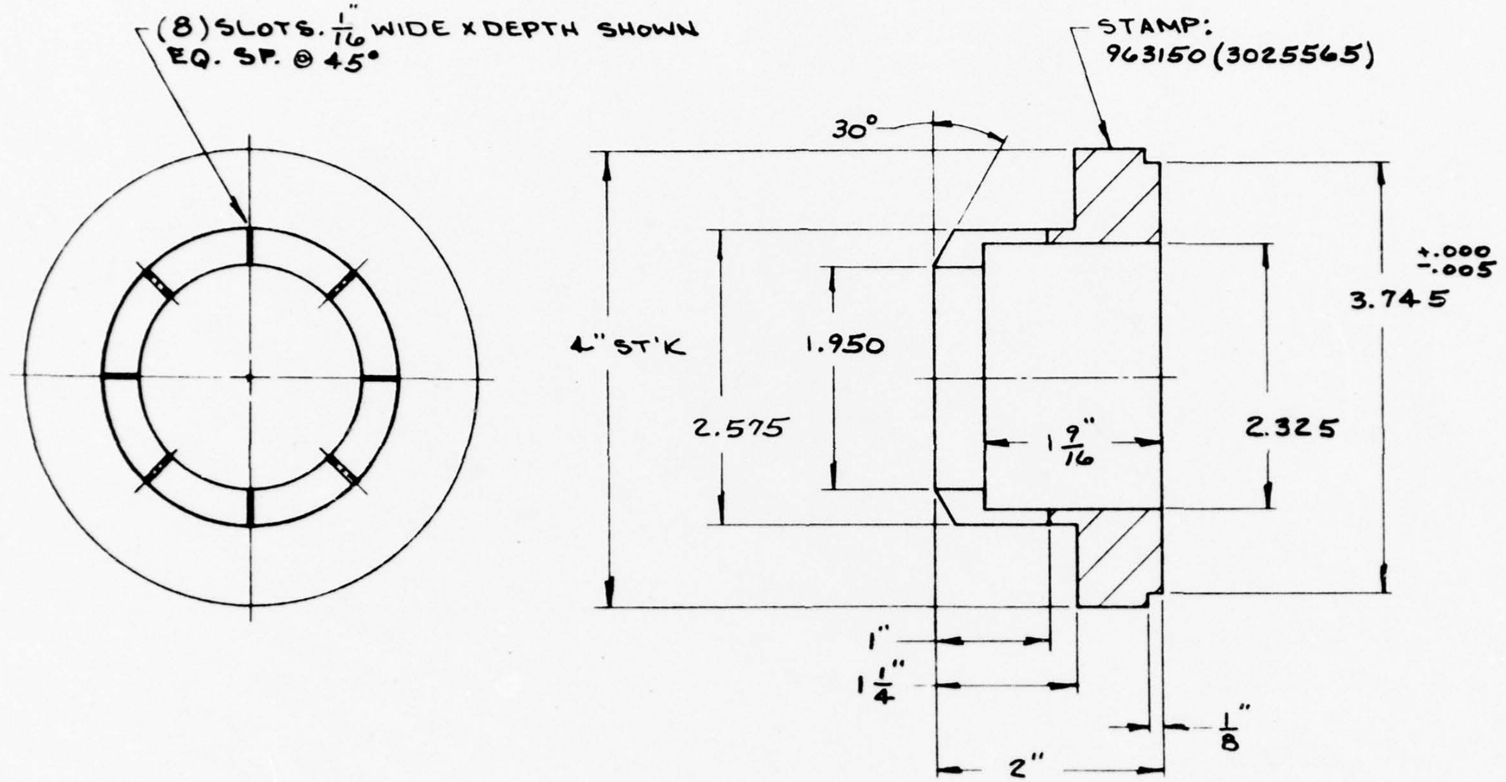
STANDARD TOLERANCE			
BASIC DIM		FRAC.	DEC.
UP TO 6"	±	1/64	.005
ABOVE 6"	±	1/32	.010
ABOVE 24"	±	1/16	.015
ANGULAR DIM. ± 1/2°			

NOTE: THREADS EXTERNAL, CLASS 2A; INTERNAL, CLASS 2B (AMERICAN STDS) UNLESS OTHERWISE SPECIFIED.
SURFACE ROUGHNESS OF 500 MICRO-INCHES OR STOCK FINISH ACCEPTABLE UNLESS OTHERWISE SPECIFIED.
NOTE: SUPPLY ALL SCREWS, NUTS, BOLTS, RIVETS, WASHERS, DOWELS, TAPER PINS, COTTER PINS & WOODRUFF KEYS WITH PART.

MATERIAL: 304 STN STL
DWG. TITLE: WAFER CONTOURING MANDREL
PATTERN NO. | SCALE: 1:1 | USED ON
DESIGN BY | MODEL NO. J15371C
RCA Electronic Components ~~EQUIPMENT DEVELOPMENT~~
DRAWN BY: R. Miles Oct. 18, 1976
SIZE: A | DWG. NO. 3025564R1

RUNING 40-22 11838



REVISIONS	
CHECKED BY	
APPROVED BY	0
(8) SLOTS. 1/16" WIDE WAS (12) SLOTS 1/32" WIDE	
R. Milo Jan. 26, 1977	1

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STANDARD TOLERANCE			
BASIC DIM.		FRAC	DEC.
UP TO 6"	±	1/64	.005
ABOVE 6"	±	1/32	.010
ABOVE 24"	±	1/16	.015
ANGULAR DIM.	± 1/2°		

NOTE: THREADS EXTERNAL, CLASS 2A; INTERNAL, CLASS 2B (AMERICAN STDS) UNLESS OTHERWISE SPECIFIED.

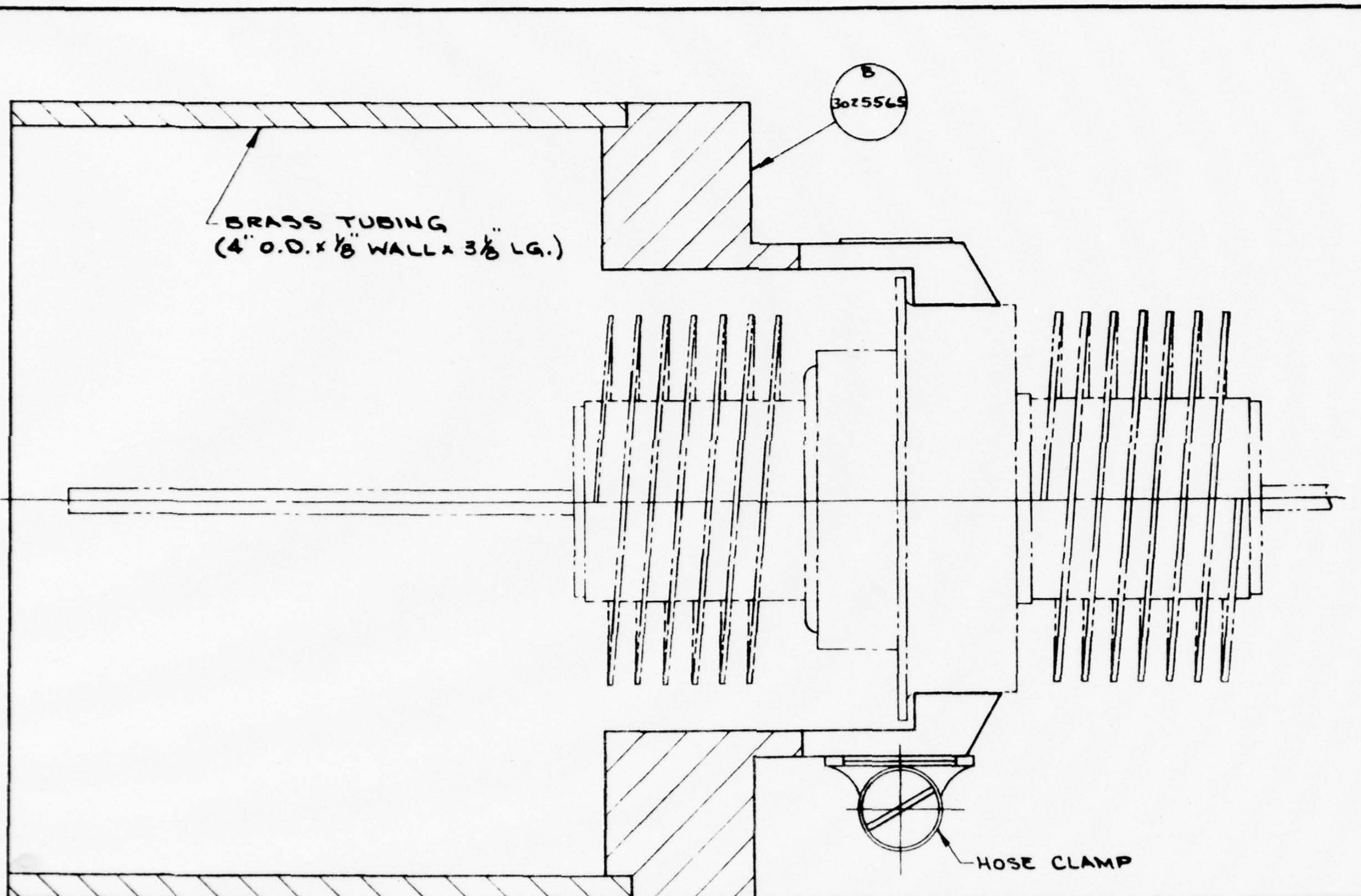
SURFACE ROUGHNESS OF 500 MICRO-INCHES OR STOCK FINISH ACCEPTABLE UNLESS OTHERWISE SPECIFIED.

NOTE: SUPPLY ALL SCREWS, NUTS, BOLTS, RIVETS, WASHERS, DOWELS, TAPER PINS, COTTER PINS & WOODRUFF KEYS WITH PART

MATERIAL: COPPER			DWG. TITLE: CLAMP RING	
PATTERN NO.	SCALE: 1:1	USED ON	DESIGN BY	MODEL NO.: J15371C
RADIO CORPORATION OF AMERICA — EQUIPMENT DEVELOPMENT			DRAWN BY: R. Milo Oct. 19, 1976	SIZE B — DWG. NO. 3025565R1

T 660 12/56

DEFIANCE NO 1020F-6 470



REVISIONS

CHECKED BY

APPROVED BY 0

ADDED NOTE 1

R. Miles Jan. 21, 1977 1

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NOTES:

1. GROUND BOTH ENDS OF DEVICE BEFORE WELDING

DO NOT USE RF STARTING CIRCUIT

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STANDARD TOLERANCE			
BASIC DIM.		FRAC.	DEC.
UP TO 6"	±	1/64	.005
ABOVE 6"	±	1/32	.010
ABOVE 24"	±	1/16	.015
ANGULAR DIM.	±	1/2°	

NOTE: THREADS EXTERNAL, CLASS 2A, INTERNAL, CLASS 2B (AMERICAN STD) UNLESS OTHERWISE SPECIFIED.

SURFACE ROUGHNESS OF 500 MICRO-INCHES OR STOCK FINISH ACCEPTABLE UNLESS OTHERWISE SPECIFIED.

NOTE: SUPPLY ALL SCREWS, NUTS, BOLTS, RIVETS, WASHERS, DOWELS, TAPER PINS, COTTER PINS & WOODRUFF KEYS WITH PART.

MATERIAL: CH

PATTERN NO.

SCALE: 2:1

USED ON

RADIO CORPORATION OF AMERICA

~~EQUIPMENT DEVELOPMENT~~

DWG. TITLE: WELDING HEAT SINK

DESIGN BY

MODEL NO. J15371C

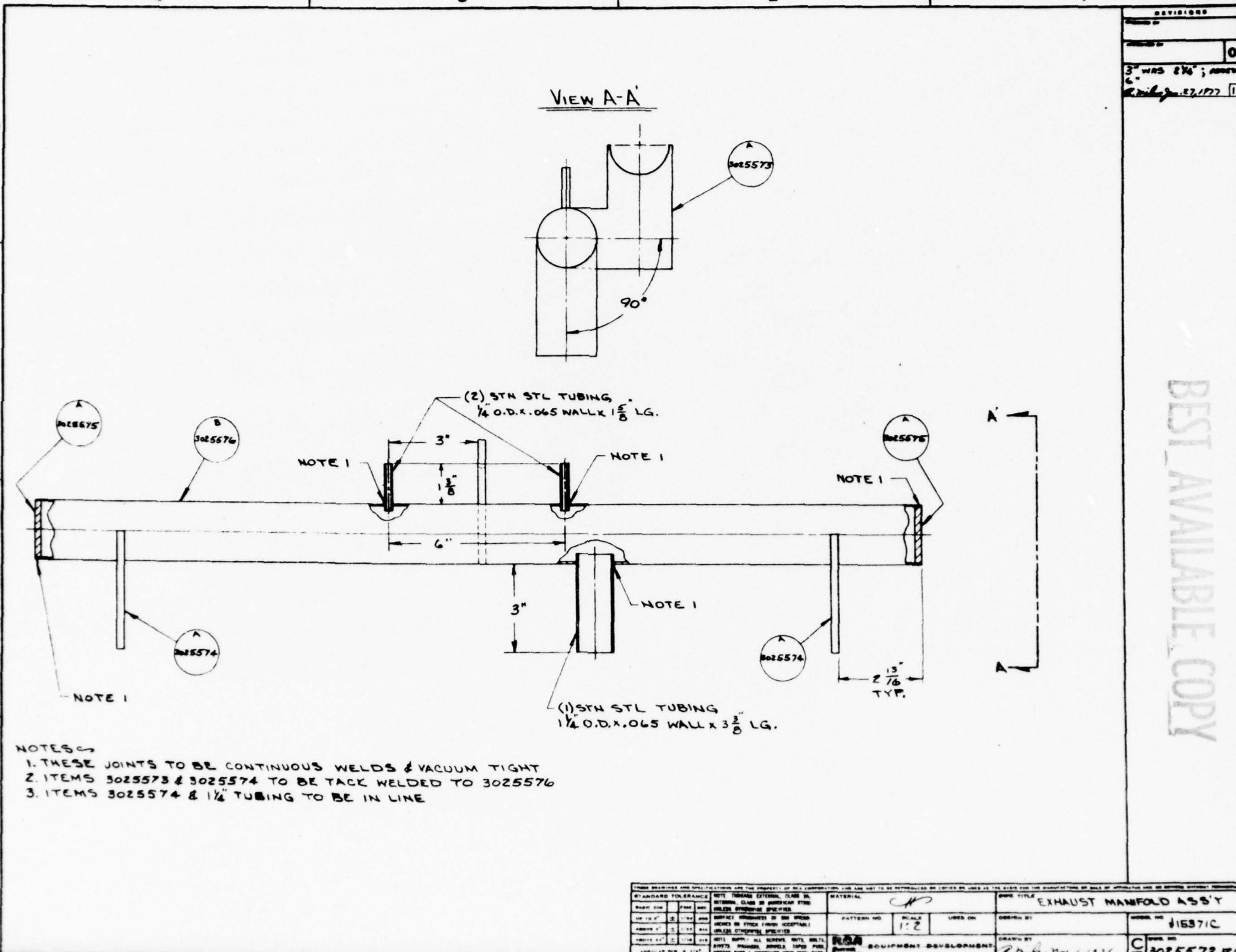
DRAWN BY: R. Miles Oct. 19, 1976

SIZE: B

DWG. NO. 3025566R1

T 660 12/56

DEFIANCE NO. 1020F-6 670



NOTES:
1. THESE JOINTS TO BE CONTINUOUS WELDS & VACUUM TIGHT
2. ITEMS 3025573 & 3025574 TO BE TACK WELDED TO 3025576
3. ITEMS 3025574 & 1 1/4" TUBING TO BE IN LINE

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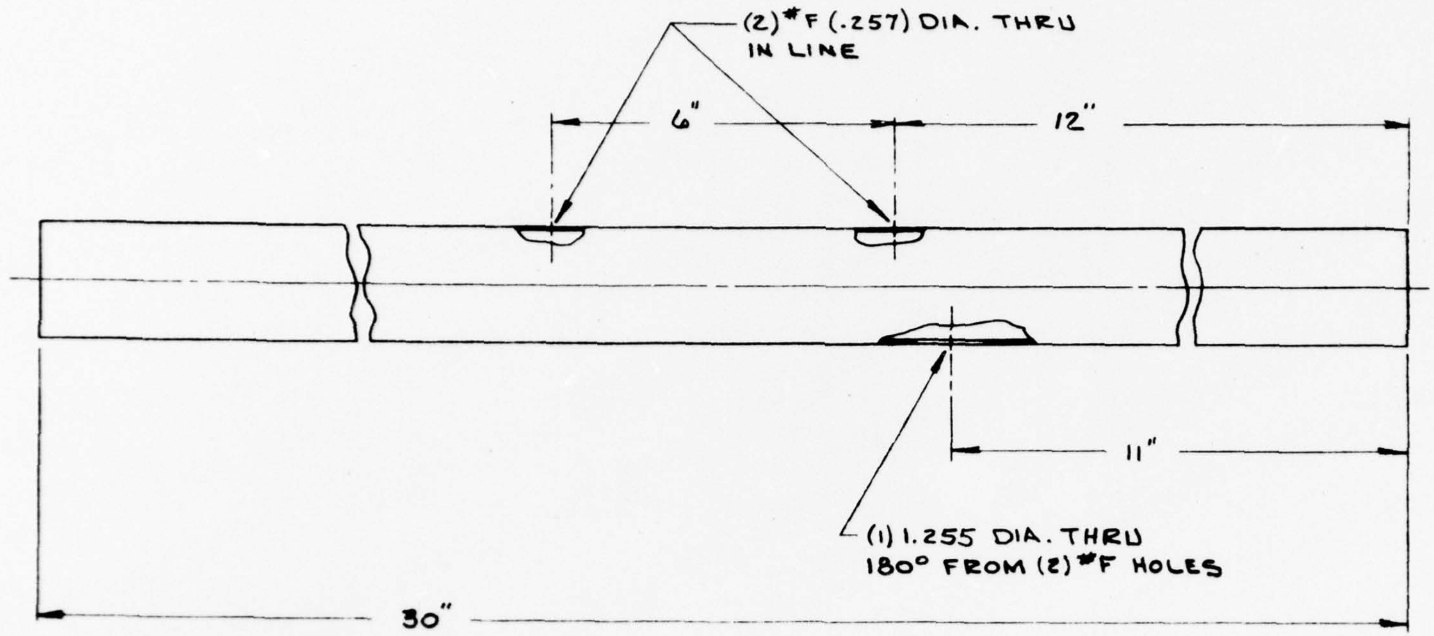

REVISIONS

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APPROVED BY — 0

12" WAS 12 3/4"; 6" WAS 4 1/2" — R. Miles Jan. 21, 1977 — 1

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STANDARD TOLERANCE		FRAC.	DEC.
BASIC DIM.		FRAC.	DEC.
UP TO 6"	±	1/64	.005
ABOVE 6"	±	1/32	.010
ABOVE 24"	±	1/16	.015
ANGULAR DIM.	±	1/2°	

NOTE: THREADS EXTERNAL, CLASS 2A; INTERNAL, CLASS 2B (AMERICAN STDS) UNLESS OTHERWISE SPECIFIED.

SURFACE ROUGHNESS OF 500 MICRO-INCHES OR STOCK FINISH ACCEPTABLE UNLESS OTHERWISE SPECIFIED.

NOTE: SUPPLY ALL SCREWS, NUTS, BOLTS, RIVETS, WASHERS, DOWELS, TAPER PINS, COTTER PINS & WOODRUFF KEYS WITH PART.

MATERIAL: 304 STN STL TUBING 2" O.D. x .065 WALL

PATTERN NO.: | SCALE: 1:2 | USED ON:

RADIO CORPORATION OF AMERICA
~~EQUIPMENT DEVELOPMENT~~

DWG. TITLE: MANIFOLD

DESIGN BY:

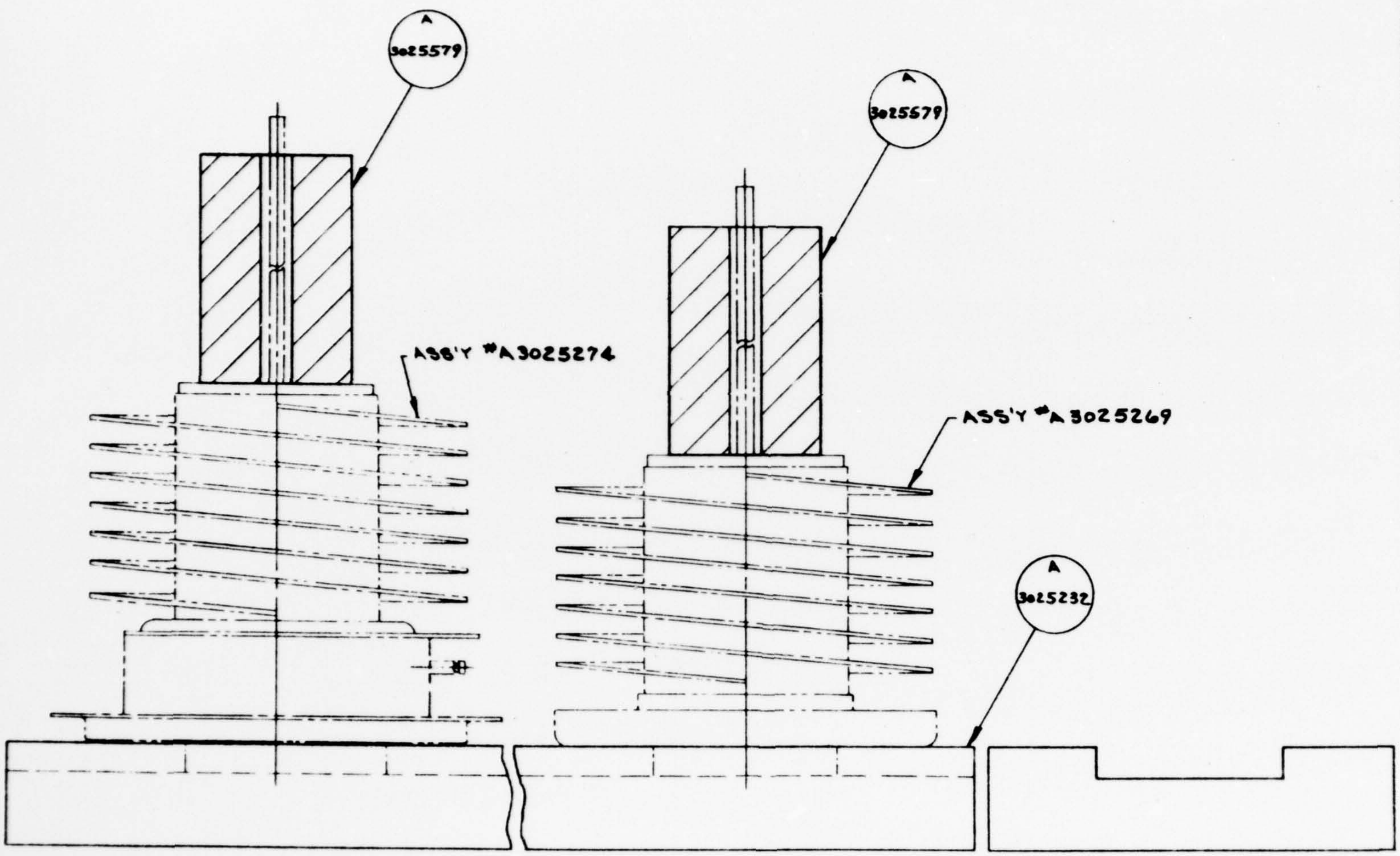
MODEL NO.: J15371C

DRAWN BY: R. Miles Nov. 1, 1976

SIZE: B | DWG. NO.: 3025576R1

T 880 12/56

DEFIANCE NO. 1880F-8 470



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STANDARD TOLERANCE			
BASIC DIM		FRAC	DEC
UP TO 6"	±	1/64	.005
ABOVE 6"	±	1/32	.010
ABOVE 24"	±	1/16	.015
ANGULAR DIM	±	1/2°	

NOTE: THREADS EXTERNAL, CLASS 2A; INTERNAL, CLASS 2B (AMERICAN STD) UNLESS OTHERWISE SPECIFIED

SURFACE ROUGHNESS OF 500 MICRO-INCHES OR STOCK FINISH ACCEPTABLE UNLESS OTHERWISE SPECIFIED

NOTE: SUPPLY ALL SCREWS, NUTS, BOLTS, RIVETS, WASHERS, DOWELS, TAPER PINS, COTTER PINS & WOODRUFF KEYS WITH PART

MATERIAL

PATTERN NO | SCALE 2:1 | USED ON

RCA Electronic Components ~~EQUIPMENT DEVELOPMENT~~

DWG TITLE ANODE & CATH. HEAT PIPE BRAZING FIXT.

DESIGN BY

DRAWN BY

MODEL NO J15371C

SIZE B DWG NO 3025583

T 600 6 68 DEFIANCE 1020F 5 5 100

APPENDIX C

Operating Procedures for the Electrical Test Equipment. Refer also to the Functional Block Diagrams for the Electrical Test Equipment included in the First Quarterly Report.

(Note: Organized in alphabetical order by Test Set title.)

EXPONENTIAL RATE OF VOLTAGE RISE (dv/dt) TEST PROCEDURE

DATE: 4/7/77 RMH

EQUIPMENT:

1. Beta High Voltage Power Supply - Connect high voltage cable to dv/dt chassis in cabinet and to 125°C oven. Connect interlocks.

   Set Up: Voltmeter Range - high
   Milliameter Range - medium

2. Tektronix Power Supply Type 160A

3. Tektronix Pulse Generator Type 161 - Plugged into 160 A.P.S.

   Set Up: Input - from sawtooth output of 162 waveform generator
   Trigger - negative sawtooth
   Output Pulse Delay - adjusted during test.
   Pulse Width - 0.1 millisecond
   Pulse Width Multiplier - adjust during test, if necessary for stability
   Pulse Amplitude - 50 volts
   Pulse Polarity - positive
   Pulse Output - to pulse input of dv/dt chassis

4. Tektronix Waveform Generator Type 162 - Plugged into 160 A P.S.

   Set Up: Operating Mode - power out
   Vernier - calibrated pos.
   Pulse Interval -1.6 milliseconds
   Multiplier - 10 (synchronize with 60 Hz line frequency)
   Gate Out - to external trigger of oscilloscope

5. Tektronix Type 545 Oscilloscope or equivalent

   Set Up: Trigger Slope - external +
   Triggering Mode - AC fast or automatic
   Time/Cm - Varied during test
   Multiplier - Varied during test

6. Tektronix Type 53/54C Plug in Unit or equivalent

   Set Up: Channel A (a) Calibrated
   (b) 2 Volts/Cm
   (c) Polarity - Normal
   (d) DC

7. Tektronix Probe P6009 100:1

   Set Up: Attached to Channel A
   Banana Plug End into DUT on the dv/dt panel

PROCEDURE:

1. Mount DUT in oven - connect to dv/dt cabinet observing polarity.*

2. Read and record DUT Temperature and connect interlock plug to side of dv/dt cabinet.

3. Turn on Pulse Amplifier and associated equipment.

4. Advance Voltage on Beta Supply to about 400 volts peak to obtain the proper trace on the oscilloscope - while setting the Time/Cm switch on the oscilloscope to 100 milliseconds. This will show if the 60 Hz required is present and also if the commuting SCR in the dv/dt test set is operating properly. Trace should be steep-wave front of the application of V_{AA} to the DUT. The trace can then be expanded by the Time/Cm switch to enable the operator to accurately read the time it takes for the voltage to reach 63.2% of V_{AA}.

*See footnote on next page.

5. The voltage is then advanced to 800 volts peak on the oscilloscope trace and the rise time read on the horizontal scale and recorded at the 63.2% voltage point on the vertical trace.

6. Calculate the dv/dt by dividing the Voltage @ the 63.2% point by the time in microseconds at that point.

7. Reduce the series resistance R1, until the threshold is reached at which the device breaks over. Increase R1 slightly and read and record this maximum dv/dt value.

8. Turn-off voltages.

9. Remove DUT from the oven using gloves to avoid burns.

*Details of High Temperature Procedure:

1. Put the DUT on the rack in the oven with the yellow wire on the anode and the braid ground strap to the cathode.

2. Plug the Jones Plug and grounding banana plug from the dv/dt cabinet into the metal junction box on top of the oven.

3. Inside the dv/dt cabinet, attach the coaxial red lead to the anode lug on the dv/dt set and the black ground wire to the ground on the dv/dt chassis.

4. Be sure that the oven interlock is plugged into the proper Jones recepticle on the side of the dv/dt cabinet.

5. Use a Minimite and thermocouple or the Mercury thermometer in the oven to check the DUT temperature.

6. Proceed with Steps 2 to 9 of PROCEDURE, above.

EXPONENTIAL RATE OF VOLTAGE RISE (dv/dt) TEST PROCEDURE (Cont.)

CALIBRATION DATES:	EQUIPMENT	DATE
	1. Tektronix 545	1/31/77
	2. Tektronix 53/54C	2/1/77
	3. Minimite & Thermocouple	Calibrate in boiling distilled H_2O prior to test.
	4. Thermometer - Mercury	Calibrate in boiling distilled H_2O prior to test.

FORWARD BLOCKING AND REVERSE CURRENT TEST PROCEDURE

DATE: 4/12/77 RMH

EQUIPMENT:

1. Forward & Reverse (High Voltage) Current Test Set

2. Oscilloscope - Tektronix Type 545 or equivalent. Set-up:

   Internal trigger - automatic
   Time/Cm - 1 millisecond (5X magnifier - off)
   Horizontal Display - Normal

3. Tektronix Type 53/54C Plug-In Unit, or equivalent. Set-up:

   Volts/Cm - 2.0 (Calibrated)
   DC condition (both channels)
   Mode - chopped
   Polarity - Normal for forward; Inverted for reverse.
   Channel A - With P6009 Probe, Peak Voltage jack
   Channel B - Peak current jack (Caution - ground only through this peak current jack to avoid erroneous reading)

4. Probe - Tektronix P6009, 100:1 voltage divider.

5. Thermometer - Mercury

PROCEDURE:

1. Warm up oscilloscope for at least 5 minutes to minimize drifting.

2. Read and record room temperature, T_A.

3. Insert DUT in cradle inside cabinet for 25°C Test or in oven for 125°C test, being careful to observe correct polarity (anode positive). Gate is open-circuited.

4. Turn-on test set and check cover interlock and oven interlock (if oven is being used).

5. Set selector switch to 10 mA forward for 25°C or 100 mA for 125° test.

6. Advance variac to read a peak of 800 volts or 4 cm vertical on oscilloscope trace for Channel A.

PROCEDURE: (Cont.)

7. Read the peak positive value of the trace on Channel B, multiply by the range setting and this product divided by 97 (ohms) to obtain the peak current. Record this current as i_{FBOM}. Turn-off voltage.

8. For the reverse direction the same procedure is followed after changing the polarity switches on the test set and on the 53/54C plug-in unit of the oscilloscope. Rezero the traces before reading.

9. The procedure is the same for use of the oven for elevated temperature testing except that the coaxial cable is attached at the rear of the cabinet and internally clipped to the anode side of the cradle and plugged into the junction box on top of the oven.

10. Turn-off equipment and carefully remove the DUT. Record the serial number on the Test Data Record form. Caution: Oven temperature may cause burns - use thermal insulating gloves.

CALIBRATION DATES:

Equipment	Date
1. Tektronix 545	1/31/77
2. Tektronix 53/54C	2/1/77

ON-STATE FORWARD VOLTAGE TEST - J-15371 TRANSCALENT THYRISTOR TEST PROCEDURE

DATE: 3/14/77 RMH/RER

EQUIPMENT:

1. Tektronix Type 545 Oscilloscope - PP88588/or Equivalent. Set-Up:

   Internal Trigger - Automatic
   Time/Cm - 1 millisecond (5X Magnifier-Off)
   Multiplier - 2 or 5
   Delay Time - 5 milliseconds

2. Tektronix Type 53/54C Plug-In Unit or Equivalent, Either Channel

   Set-Up: DC
   Normal Polarity
   Volts/CM - 0.5, Calibrated

3. Minimite & Thermocouple
   Check Meter Zero & Standardize before using.

4. Dwyer Pitot Tube - Level before using.

5. Thermometer - Mercury

6. A.C. Power Supply - PP 883232

PROCEDURE:

1. Warm-Up Oscilloscope for at least 5 minutes.

2. Read & record the device serial number and the room ambient temperature, T_A, from the thermometer (25 $\pm$ 3^{o}C).

3. Bolt device under test (DUT) anode to stationary side of air chute and attach flexible heavy cable to the cathode. Use an Allen Wrench to hold studs while tightening connectors.

4. Connect white wire to gate pin.

5. Turn on blower at full speed. Caution - Do not apply power to DUT without adequate air cooling.

6. Connect red oscilloscope lead to anode; black to the cathode-connect on the DUT not on the current-carrying connectors.

   Set oscilloscope trace on a convenient base line.

PROCEDURE (Cont.)

7. Turn on power supply and advance current to 250 amperes average current. Measure conduction angle (160° minimum).*

8. Set blower to speed where hottest heat-pipe of DUT holds $100^{\circ}C$, measured at the base of the fins with the Minimite and thermocouple.

9. Read and record peak forward voltage, V_{FM}, on oscilloscope trace.

10. Read and record air flow with Pitot Tube and convert to C.F.M. (150 C.F.M. Max.).

11. Read and record both heat-pipe temperatures at base of fins (balanced cooling check).

12. Turn off equipment and carefully remove the DUT from test set.

CALIBRATION DATES:	EQUIPMENT	DATE
	1. Tektronix 545	1/31/77
	2. Tektronix 53/54C	2/1/77
	3. Minimite & Thermocouple	Calibrate in boiling distilled H_2O prior to test.
	4. Thermometer - Mercury	Calibrate in boiling distilled H_2O prior to test.

*A minimum 160° of conduction angle is 7.41 milliseconds minimum base width of the conducted one-half cycle as viewed on the oscilloscope.

THERMAL IMPEDANCE TEST SET TEST PROCEDURE

DATE: December, 1976

EQUIPMENT:

1. Heating Power Supply, Rapid Electric, Model #1006
2. Metering Power Supply, Lambda, Model LMFA8
3. Trigger Power Supply, Tektronix 160A
4. Pulse Interval Control, Tektronix Type 162 Waveform Generator
5. Commutating & Heating SCR Trigger Sources (2) Tektronix Type 161 Pulse Generators
6. Trigger Pulse Dual Amplifier, RCA constructed
7. Oscilloscope - Utilized for forward voltage measurement. Tektronix Type 546 with type W plug-in unit.

PROCEDURE:

1. Cooling - Turn on water cooling of the heating power supply as well as the blowers for the commutating SCR, the switching SCR, and the DUT. Use the variac control to adjust the cooling air flow on the DUT to the desired value for the thermal impedance test.
2. Mount the DUT with the anode connected to the switching SCR and the cathode connected to the current shunt and water cooled resistor.
3. Turn on the metering current supply and the DUT. Adjust the metering current to 4 amps. Turn on the commutating power supply and adjust the commutating current in accordance with the following table.

Heating Current	Tektronix 162 Pulse Interval	Metering Power Supply Current
100 amps	5 X 10 millisec	1½-2 amps
200 amps	5 X 10 millisec	2-2½ amps
300 amps	6.3 X 10 millisec	3-3½ amps
400 amps	8.0 X 10 millisec	3½-4 amps
500 amps	10 X 10 millisec	3½-4 amps

In general, the commutating current values given in the table, above, should be adjusted for the particular heating current utilized to secure a stable oscilloscope reading of the metering current interval. Also, the waveform generator pulse interval should be the minimum that provides a readable oscilloscope presentation. Minimizing the pulse interval increases the duty factor of the heating current and, thus, the accuracy of the measured dissipation.

4. Turn on the power supply for the waveform and pulse generators as well as the dual trigger pulse amplifier. Adjust the commutating SCR trigger for a pulse amplitude of about 15 volts, a pulse width of 3/10 to 4/10 millisec. and an output pulse delay of 0.3. Pulse polarity should be positive and the trigger selector should be set for a negative sawtooth. The heating SCR trigger generator should have the following settings: Pulse amplitude 3-4 volts, pulse width 3-4 milliseconds, pulse delay approximately 0.32 (adjust for proper oscilloscope presentation), positive pulse polarity, and a negative sawtooth trigger selector.

5. Turn on the heating current supply and adjust to 250 amperes for the measurement of thermal impedances for the MM&TE program. Note that the commutating current supply must be adjusted at this heating current level and the metering current should be read and adjusted, if required. A Model 8000A millivoltmeter or equivalent should be utilized to measure and read the heating current on the 500 ampere, 15 millivolt shunt as well as the average forward voltage drop across the DUT. The product of these two values and the duty factor is the average dissipation of the heating supply.

5. (Continued)

Instantaneous forward voltage drops across the DUT are to be measured by the Type W plug-in unit in the 536 oscilloscope. This value at the 4 amperes level can be used to determine the junction temperature from a previously measured calibration curve of forward voltage drop vs. device temperature.

6. The thermal impedance measurement also requires an accurate reading on the ambient air temperature as well as the case temperature of the device (outside surface of the heat pipe at the base of the colling fins). The thermal impedances can then be calculated.

7. Read and record the cooling air flow before turning off all supplies and removing the DUT from the test circuit.

PRECAUTIONS:

Care should be taken at each step in the heating current to enable the DUT to achieve thermal equilibrium before temperature and voltage readings are recorded. Similarly, the oscilloscope presentation of the metering current must be extrapolated to the leading edge of the off interval for an accurate indication of the forward voltage drop on the silicon wafer at the instant the heating current is turned off. The negative spike overshoot of the forward voltage is ignored for this reading, and only the extrapolated value is utilized for measurement purposes.

Care should be taken throughout the thermal impedance testing to avoid overheating the junction of the DUT, i.e., the junction temperature should not be allowed to exceed 130°C! Higher temperatures may result in permanent damage to the DUT

Forward voltage measurements by either the Fluke voltmeter or the type W plug-in of the oscilloscope must be connected only to non-current carrying portions of the DUT. Measurements across current-carrying connectors will introduce additional error due to the forward voltage drop of the high current connections.

PRECAUTIONS: (Continued)

It is imperative that the oscilloscope be "floating" off ground potential at all times for these measurements since the ground terminal of the type W plug-in unit is operating at a potential different from the power system ground. This is true because both the anode and cathode of the DUT are operating at potentials that differ from the power system ground by several tenths of a volt to as much as one volt or more. Very low voltages are involved in the test (less than 12 volts on the DUT) so that no safety hazard exists.

CALIBRATION DATES:

Equipment	Date
Oscilloscope	11/9/76
DUT Voltmeter, 8030A	2/11/77